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THE THORACIC LIPOMAS*

By GEORGE J. HEUER, M.D.

OF NEW YORK, N. Y.

THE subject of intrathoracic tumors has already become so large that it is difficult to deal with it in a short paper. Just as we have, for some years past, found it necessary to devote ourselves to a single form of brain tumor in our papers and discussions, so now it seems desirable to discuss single forms of intrathoracic tumors. In previous papers I have assembled and discussed individual groups of intrathoracic tumors, such as the dermoid cysts, the chondromas and chondromyxomas, and the hour-glass tumors of the spine which involve the thorax. In the present paper I wish to discuss the group of intrathoracic lipomas.

The incentive for this study is a remarkable case of intrathoracic lipoma referred to me by Dr. James Alexander Miller.

The patient, an unmarried young woman, twenty-four years of age, was admitted to the Surgical Service of the New York Hospital, December 5, 1932, complaining of pain in the chest, shortness of breath, choking sensations and palpitation of the heart. Her family history is unimportant. Her past history, in view of the condition she presented, seems remarkably free from illnesses of any sort. Closely questioned, she failed to remember any definite symptoms referable to her chest before the onset of her present illness. This occurred February 11, 1932, with a sharp, stabbing pain in the left chest and back, intensified with each respiratory effort. She developed marked difficulty in breathing and the following day was so ill that she was taken to the Cooper Hospital in Camden, New Jersey. She arrived there in poor condition, ashen in color, and profoundly prostrated. X-rays of the thorax were made which showed a diffuse shadow over the left thorax; and with the possibility in mind that the shadow might be due to fluid, her left thorax was repeatedly tapped but without obtaining fluid. Two weeks later she was transferred to the Jefferson Hospital where a bronchoscopic examination was made. The bronchoscopic examination (according to the patient) showed a narrowing of the left bronchus due to pressure upon it. She returned to the Cooper Hospital where a left pneumothorax was induced. Her chest was again tapped and again without result. She went home and sometime thereafter caught a severe cold which intensified the thoracic pain and dyspnoea. She recovered from this but her general condition gradually became worse. In August, 1932, she had a bout of more severe illness, during which she was in bed with some fever, marked dyspnoea and tachycardia, and severe pain in her chest. In November, 1932, the patient consulted Dr. James Alexander Miller, who made a diagnosis of intrathoracic tumor and referred her to me.

On admission the patient proved to be an intelligent, optimistic girl. She did not appear ill, was of good color but evidently had lost some weight. She was slightly dyspnoeic when she talked, and had a periodic hacking cough. Physical examination other than that of her chest was essentially negative. There was no ascites, no oedema of the extremities, and no clubbing of the fingers. The thorax on inspection was mark-

* Read before the New York Academy of Medicine, April 7, 1933.

edly asymmetrical. There was a noticeable bulging of the left half of the thorax anteriorly and some, although less, bulging of the left lateral and posterior thoracic wall. The cardiac impulse could be seen displaced far to the right; and on palpation the apical impulse was in the fourth interspace, nine centimetres to the right of the mid-sternal line. The respiratory movements were restricted over the entire left thorax. On percussion there was dullness to absolute flatness over the entire left thorax, both anteriorly and posteriorly. On auscultation the breath sounds were diminished to absent over the left thorax. The cardiac sounds were rather feeble but normal; the rate rapid, the rhythm normal.

The anteroposterior X-rays of the thorax show a diffuse, illy defined shadow almost completely filling the left thorax. The heart is displaced far to the right, the apex almost reaching the right lateral thoracic wall. The lateral X-ray films show that the shadow does not occupy the upper thorax anteriorly nor the lower thorax posteriorly. (Figs. 1 and 2). A minute examination of the shadow shows some features of impor-



FIG. 1.—Anteroposterior X-ray film of the thorax showing the extent of the shadow cast by the tumor and the displacement of the heart to the right.



FIG. 2.—Lateral X-ray film of the thorax showing the extent of the shadow cast by the tumor.

tance in diagnosis. Compared with the dense central portion of the shadow, the margins of the shadow suggest transparency unlike the shadow cast by a massive collection of fluid and unlike the shadow of other benign and malignant tumors. In a clinic given before our medical students I pointed out that a lipoma would be the most likely tumor to cast a shadow such as this and suggested the diagnosis of intrathoracic lipoma.

It seemed highly desirable to know the nature of this tumor; and I suggested to the patient that she allow me to explore it. She readily consented and the operation was performed December 10, 1932. Under local anæsthesia with novocaine, 8 centimetres of the fifth rib over the lateral thoracic wall were resected. The parietal pleura was stripped from the thoracic wall over a considerable distance. Immediately beneath it there presented the exposed portion of the tumor with its grayish-white capsule. Palpation of the tumor suggested a cystic growth. A large aspirating needle was, therefore, inserted into the tumor and five cubic centimetres of a yellowish, sticky, mucoid fluid drawn into the syringe. This, on microscopical examination, showed large quantities of fat droplets, fat cells and a few epithelioid cells. Doctor Foot, our surgical pathologist, was of the opinion that the tumor was a lipoma. To make the diagnosis more certain,

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an incision five centimetres long was made through the capsule of the tumor. The capsule at the place the incision was made was very thin; beneath it was a layer of tissue one centimetre thick, which grossly resembled fat, and beneath this was a broken-down, greenish-yellow myxomatous material which could be readily removed without bleeding. Material from these parts of the tumor was removed for examination. The exploration was then abandoned, and the wound closed without drainage. There was no upset of any sort during the procedure.

The post-operative convalescence following this operation was uneventful. The wound healed *per primam*. The question arose whether anything further might be attempted toward the removal of the tumor. It was realized that the tumor was of enormous proportions, and that its enucleation *in toto* was quite impossible. But it was thought, in view of the findings at exploration, that a large part of the degenerated myxomatous material might be removed intracapsularly, and I considered the wide exposure of the tumor through the resection of several ribs, the incision and suture of the capsule to the thoracic wall and the removal from within the capsule (in several stages if necessary) of the degenerated central portion of the tumor. I finally suggested this operation to the patient and again she readily agreed.

This operation was to have been performed January 5, 1933, but was not carried into effect. The patient was placed on the operating table and the infiltration of the field of operation with novocaine was begun. Before it was completed the patient complained of feeling queerly, and I attempted to reassure her. She failed to answer and I immediately stopped the infiltration of the operative field. She made some unintelligible noises, evidently attempts at speech, then went into a generalized convulsion. All parts of her body were involved, the pupils were dilated and she became cyanotic. One convulsion succeeded another. An intratracheal catheter was quickly passed and artificial respiration begun. The patient died at the end of a convulsive seizure. The symptoms leading to death were those described as pleural reflex or pleural eclampsia.

I shall not relate in detail the necropsy findings but confine myself to those of great interest. On opening the abdomen the most striking feature was the marked downward bulging of the entire left diaphragm and to a lesser degree the right. The liver was pushed downward so that its edge was eight centimetres below the costal margin and the upper portion of the left lobe was flattened and almost concave, due to the pressure from above. There was no free fluid in the abdominal cavity.

On removing the anterior thoracic wall the entire thoracic cavity seemed filled with a large, smooth, rather yellowish, more or less spherical tumor mass. The heart and lungs could not be seen. *In situ* at its widest diameters the tumor measured twenty-five centimetres in its vertical and transverse diameters. The greater part of it lay in the left thorax but posteriorly it filled as well the lower portion of the right thorax. There were few adhesions between it and the thoracic wall except at the site of the previous operation and when these had been divided the tumor easily could be delivered from the thoracic cavity. The tumor, the heart and the lungs were removed *en masse* and together weighed 5.65 kilograms (12½ pounds). (Figs. 3 and 4.)

Examination of the relationships to the heart and lungs shows that the tumor arose in the anterior mediastinum. It measures twenty-five by twenty-five by thirteen centimetres in diameter, is fairly firm but suggests fluctuation on palpation. The capsule is smooth, yellowish or grayish-white and varies in thickness. After hardening in formalin the tumor was sectioned, showing an outer capsular layer, varying in thickness and made up of fatty tissue, and a central mass made up of degenerated myxomatous material. (Fig. 5.)

The left lung was very small, totally collapsed and atelectatic and completely flattened over the posterior upper margin of the tumor. The right lung was considerably encroached upon but was crepitant throughout. The heart was small and atrophic. The pericardium was thickened and showed a fine fibrinous pericarditis. The posterior surface of the tumor was quite densely adherent to the anterior pericardium.

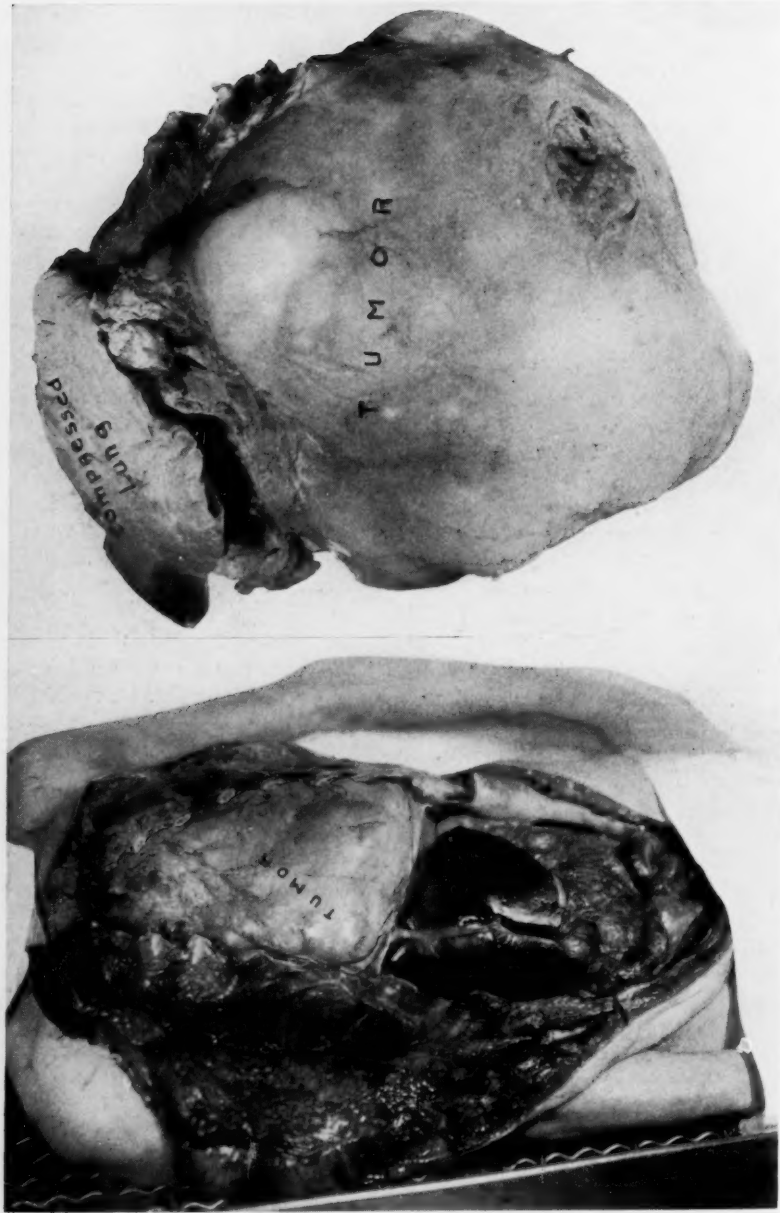


FIG. 3.—Photograph of the body at the post-mortem after the removal of the sternum and ribs. The entire anterior thorax is filled by the tumor. The heart and lungs cannot be seen. The diaphragm is depressed. The liver is small.

FIG. 4.—Photograph of tumor after removal from the thorax. The compressed lungs are attached to the specimen.

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With the peculiarity of the patient's death in mind the surface of the parietal pleura under the field of infiltration was carefully examined. No puncture wounds of the pleura could be demonstrated. The brain was removed and examined in detail. Nothing abnormal was found excepting some small air bubbles in the superficial veins over either hemisphere of the cerebrum.

Comments.—There are a number of features in this case which perhaps are worthy of mention. Considering the size (twelve and a half pounds) which the tumor had attained, it seems remarkable that symptoms referable to it should have been present only ten months before the patient came under our observation. But other similar tumors which will be cited further on, have also reached an enormous size before causing



FIG. 5.—Section of tumor showing outer capsule of fat and central myxomatous material.

marked pressure symptoms and it is evident that the intrathoracic organs may endure great compression if the compression is exerted slowly and progressively. The clinical and the X-ray findings both suggested fluid in the chest and justified the repeated aspirations. The diagnosis of tumor having been established, the character of the shadow cast on the X-ray film by the tumor strongly suggested the nature of the growth. The dramatic death of the patient coming on so unexpectedly and so suddenly with major convulsive seizures is an unforgettable experience, and is the first that I have had. The symptoms resembled those described in pleural reflex or pleural eclampsia, but whether the condition was this remains problematical. The patient had been repeatedly tapped before operation without untoward symptoms. She had been operated upon before without symptoms. The autopsy showed that the needles used in infiltration of the thoracic wall with novocaine had not at any point penetrated the pleura. The suggestion has been made that this was a novocaine death. In regard to this it is to be noted that

in the previous operation as much novocaine was used without ill effect; and that an interval of twenty-six days elapsed between operations. It was noted at autopsy that some of the cerebral vessels contained air emboli and the question was raised whether air embolism might not have caused the fatal outcome. In regard to this there was no evidence at autopsy that either a vein or an artery in the thoracic wall was punctured during the infiltration of the tissues. Moreover, the occurrence of air in the cerebral vessels at autopsy is not uncommon. As Meagher suggests, if the skull cap is pulled off after the large vessels at the root of the neck have been divided, the increase in the intracranial space due to the removal of the skull cap will cause air to be sucked up into the cerebral vessels.

The Literature on Intrathoracic Lipoma.—In the literature from 1783 to the present time, I have found records of twenty-eight cases of thoracic lipoma, exclusive of those reported as lipomas of the pericardium. The first case which I was able to find was reported by Fothergill in 1783, the second by Cruveilhier in 1856. In the forty-four-year period between 1856 and 1900, eleven cases are reported; in the period from 1900 to the present time, fifteen cases are recorded. In twenty-six of the twenty-eight cases the original articles were available to me; in two cases the original articles were not found or were not available. These are the cases of Auvray cited by Garré, and of Chiari cited by Gussenbauer.

In reviewing these cases it becomes apparent that the thoracic lipomas may conveniently be divided into three groups; first, a group in which an intrathoracic tumor is continuous with an extra-thoracic tumor giving rise to a growth with an hour-glass form; second, a group in which a mediastinal tumor extends into the neck; third, a group in which the tumor lies entirely within the thoracic cage. I shall discuss the three groups in the order given.

(1) *The Hour-Glass or Dumb-Bell Tumors.*—Of the twenty-eight cases of thoracic lipoma, nine belong to this group. They are characterized by possessing two masses connected by a constricted portion or isthmus. The one mass lies within the thoracic cage, the other lies external to the bony thorax. The constricted portion occupies a perforation in the thoracic wall, usually between the ribs. A study of these nine cases shows that in size the *external tumor* varied from that of a walnut to that of a man's head, the majority being fairly large tumors; and in position presented over the anterior thorax to the right or left of the sternum in five cases, and under the left breast, in the right axilla, over the lateral thoracic wall and over the back below the left scapula, each in one case. The perforation in the thoracic wall occurred in an intercostal space in all but one case and varied in size up to that of the diameter of "an egg." The constricted portion of the tumor corresponded in size with that of the perforation in the thoracic wall. The *intrathoracic portion* of the tumor varied in size, as did the extrathoracic, the largest recorded specimen being about the size of an "infant's head." The patients harboring these tumors varied in age from one to fifty-six years. Three of the patients were male children, one year, fifteen months and twenty-two months of age respectively; one was a boy eighteen years old; and four were adults over forty. It is to be noted that in the three children the external tumors were discovered

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when they were six months of age; an indication that the tumors may have been congenital.

The symptomatology of the hour-glass lipomas need only briefly be discussed. In all nine cases there was a visible, palpable, external tumor. They had been discovered for from three months to three years before the patients had come under the observation of the physician. The subjective complaints as noted in the case histories are rather few and relatively slight. In two cases the condition was symptomless, in four pain was the chief complaint, and in two dyspnea (in one with cyanosis) was the most noticeable symptom. On physical examination the external tumor is described as soft and fluctuant with a smooth or lobulated surface to which the overlying skin is not attached; and in three cases in addition it is noted that the tumor was fixed to the thoracic wall. The physical findings with reference to the thorax are noted in only four cases; in two they are reported as normal, and in two, dullness on percussion in the region of the external tumor and diminution in the breath sounds on auscultation are recorded. X-ray reports are given in two cases; in one the chest was reported as normal, in the other it showed an intrathoracic shadow. Aspiration of the external tumor is recorded in three cases, in each with negative results. A positive diagnosis of the true nature of the condition is recorded in only one case in which the X-ray showed a tumor shadow within the thorax. The external tumor was correctly diagnosed in three cases but an intrathoracic extension of the tumor was apparently missed. In one case the external swelling was diagnosed a cold abscess.

The treatment in all of these hour-glass lipomas was surgical and consisted in the attempt to remove the tumors. In the dissection of the external tumor it was found that the narrowed isthmus of the tumor perforated the thoracic wall; in the second intercostal space in two cases, in the third intercostal space in two, and in the fourth, sixth and seventh intercostal spaces each in one case. In one case the exact intercostal space is not noted. In one case the tumor perforated the sternum. In six cases both the external and internal tumors were removed; in three the external tumor alone was removed. Following operation five cases recovered and were cured; four died and came to autopsy. An analysis of the deaths shows that all resulted from infection presumably due to faulty surgical technic. The deaths occurred in the years 1856, 1875, 1876 and 1889, before aseptic technic had been developed. The three cases in which only the external tumor was removed all died of infection.

The Origin and Development of the Hour-Glass Lipomas.—Perhaps the most interesting feature of the hour-glass lipomas and similar tumors is the consideration of their origin and development. The views expressed in the literature are many and varied. I shall omit the earlier discussions of Virchow, Billroth, Cohnheim and others regarding the origin of deep-seated lipomas in general and the later discussions as to whether these tumors are true tumors or the result of the hypertrophy of local collections of fat. Two views developed as to their origin and direction of growth. According to one view they have their origin in the mediastinum or in the subpleural space and

force their way through the intercostal space; according to the other they arise outside the thoracic wall, penetrate the intercostal space, and extend into the mediastinal or subpleural space. Rokitansky assumed that they arose outside the thoracic cavity and penetrated the thoracic wall; and Czerny after a study of his case was of the same opinion. Harms believed that they originated in the musculature outside the thoracic wall and penetrate it, basing his opinion on the mistaken information that lipomas do not occur as intrathoracic tumors only. Gussenbauer on the other hand thought that the tumor in his case originated in the subpleural space and penetrated the thoracic wall externally, basing his belief on the finding that the external portion of the tumor was covered by the endothoracic fascia. Garnier thought that the tumor in his case arose in the anterior mediastinum and, in expanding, extruded through a defect in the sternum. Beyers found it difficult to say whether the tumor in his case originated in the extrapleural or extrapericardial fat or in the loose areolar tissue which fills the anterior mediastinum. He questioned whether it was possible for a soft tumor like a lipoma to penetrate the thoracic wall through an extremely narrow interchondral space occupied by the intercostal muscles and intercostal membrane and strengthened by slips of the triangularis sterni muscles. He believed that possibly the increase in size and vigor of the heart may have assisted in its extrusion, but thought that in its growth the tumor would be more likely to take a direction of lesser resistance into either pleural cavity. Yates and Lyddane also questioned the probability of a tumor, originating internally, penetrating the thoracic wall, but expressed the possibility that the pressure exerted by the heart's action and the lungs during inspiration may be sufficient to force a part of the tumor through a congenitally weak spot in an intercostal space.

Coenen, in 1927, expressed another view which, to me, seems to explain these tumors better than those just mentioned. He conceives of these tumors as congenital, appearing early, before the bony structures of the thorax have fully developed. In the development of the thoracic cage the tumor, playing a passive rôle, is impinged upon and constricted with the formation of an extra- and intrathoracic tumor. A study of the nine cases of hour-glass lipoma shows that three were first discovered in infants six months of age—an indication, certainly, that in these cases the tumor was congenital. With possibly one exception, the intrathoracic portion of the tumor lay in the mediastinum, a favorite site for congenital tumors (dermoid cysts, teratomas, *etc.*). Moreover, analogous tumors are found in other parts of the body. In a previous paper on the hour-glass tumors of the spine, I pointed out that the characteristic of these tumors is that they possess an hour-glass shape, the constricted portion of which occupies an intervertebral foramen; the one enlarged portion occupies the spinal canal, while the other enlargement lies in the tissues of the neck, the mediastinum, *etc.*, depending upon the level of the growth. These tumors are chiefly the neurinomas, neurofibromas and fibromas; one is a lipoma. In this paper I called attention also to certain fibrolipomas of the spine associated with spina bifida occulta which present similar characteristics;

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to certainly similarly shaped dermoid cysts of the head; to the rather rare upper epigastric herniæ which apparently perforate the xiphoid; and to the persistent thyroglossal ducts which apparently perforate the hyoid bone. In these various conditions somewhat similar factors as regards the growth and shape of the tumors must obtain. It seems doubtful that a soft tumor like a lipoma arising either within or without the thoracic cage would perforate the rigid wall of the thorax rather than grow locally within or without the thorax; or that a fibrolipoma of the spine would force its way through vertebral laminae rather than grow within the spinal canal or in the muscles of the back. Would it not appear more logical, for example, in the latter case, to assume that the failure of the laminae to fuse was due to the interposition of a pre-existing fibrolipoma, rather than that a fibrolipoma just happened to occupy an unexplained defect in the spine?

(2) *The Superior Mediastinal Lipomas Presenting at the Root of the Neck.*—There are only three cases of this sort reported. The tumors apparently arise in the anterior superior mediastinum and extend upward presenting as visible palpable tumors at the root of the neck; either directly above the manubrium or to one side of the suprasternal notch. In Graham's case the tumor measured nine by five centimetres in diameter; in Beatson's case it was about the size of an "orange"; in Lemon's case it was larger than a "quart cup."

The patients harboring these tumors were men of forty-three, forty-five and forty-six years of age. The tumors of the neck had been present for six months, eighteen months and five years before coming under observation. The symptoms varied. In Beatson's case they were inconspicuous or absent; in Graham's case they consisted of pain in the neck, choking spells, dyspnoea, cyanosis and hoarseness; in Lemon's case, when first observed, of mild dyspnoea and occasional hemoptysis but later, before death, of severe dyspnoea, cyanosis and paroxysmal cough. Except for the external tumor the physical examination in Graham's and Beatson's cases failed to show any noteworthy abnormal findings; in Lemon's case it showed mediastinal dullness on the right, diminished excursion and distant breath sounds on the right, and displacement of the heart to the left. The X-ray of the thorax in Graham's case failed to show a mediastinal shadow; in Lemon's case it showed a large, lobulated, mediastinal tumor extending into the right thoracic cavity. Of the three cases Graham's and Beatson's were subjected to operation, and in both the tumor was successfully removed through a "collar" incision with the cure of the patients. Lemon's case, notwithstanding a correct diagnosis, was treated by radiotherapy and died two years later.

(3) *The Intrathoracic Lipomas.*—Exclusive of the case I have presented, there are sixteen cases reported in which the tumor lies entirely within the thorax. They are scattered through the literature from 1783 to the present time and are often incompletely reported. Of the sixteen cases, ten and, probably, eleven died, according to the case records, of other conditions without a diagnosis of an intrathoracic tumor having been made. One died of

cerebral hæmorrhage, two of pneumonia, one of fracture of the femur, one of empyema, one of Bright's disease and endocarditis, one of pericarditis, and one of angina pectoris. In three the cause of death is not stated. In the majority, certainly, the condition was not suspected until revealed by autopsy. In only five cases, those of Sauerbruch, Leopold, Klemperer, Garré and Rütz, was a positive diagnosis of intrathoracic tumor made before operation or autopsy; but in none a diagnosis of intrathoracic lipoma. In size the tumors greatly varied. Chiari's case presented a tumor the size of a "walnut"; Leopold's an enormous tumor largely filling the thorax and weighing seventeen and one-half pounds. Of the eleven cases in which the size of the tumor is stated, three were fairly small (not larger than a "goose egg"), and eight were quite large. That some of them should not have caused more outspoken symptoms during life seems remarkable. The patients presenting these tumors included twelve men and four women who varied in age between twenty-eight and sixty-five years. In only five cases is the duration of symptoms clearly stated; one patient had dyspnoea for twenty years; two for twelve years; one for two years; one for one month. The symptomatology as detailed in the case reports is very much confused. In three cases the tumors were of such size that in all likelihood they failed to provoke symptoms during life. In two cases the symptoms and physical signs were those of an acute pneumonia and quite overshadowed symptoms of tumor if such were present. In one case the symptoms and physical signs were those of empyema, and in one the symptoms were those of angina pectoris. One case presented the symptoms of dyspnoea, cyanosis and fever and died of pericarditis. In one case the symptoms, if any, are not detailed. In only six cases are symptoms and physical signs recorded which may be attributed to the intrathoracic lipoma; and in these the symptoms and physical signs were those common to intrathoracic tumors generally, *i.e.*, pain in the chest, cough, a varying degree of dyspnoea and cyanosis and cardiac irregularity. In three cases it is evident that the symptoms of an intrathoracic tumor were present for twelve to twenty years although not severe enough to warrant medical attention. Leopold's case before death developed an astonishing degree of dyspnoea and cyanosis in addition to ascites and cedema of the abdominal wall, genitalia and lower extremities. X-ray examinations are definitely recorded in only four cases, those of Sauerbruch, Garré, Klemperer, and Yates, and showed a shadow in the thorax. The cases of Sauerbruch, Klemperer, and Garré were uncomplicated and a diagnosis of intrathoracic tumor was made; that of Yates was complicated by an acute pneumonia which undoubtedly confused the picture. Altogether the intrathoracic lipomas have, thus far, been a confusing group from the standpoint of diagnosis; and, as noted, a diagnosis of tumor was made in only five cases and in none a correct diagnosis of intrathoracic lipoma.

Of the sixteen cases, thirteen died untreated with respect to the tumor; three were subjected to surgical operation (cases of Sauerbruch, Garré and Rütz). In the latter three cases the tumor was completely removed with the recovery and cure of the patients.

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The origin of these intrathoracic lipomas is indeed difficult to determine from the case reports; and having seen the autopsy on the case I have presented, I can understand the difficulties pathologists have had in making accurate statements. In the cases of Conner and Clark, the tumor is stated to have been covered by the diaphragmatic pleura, and in Clark's case the base of the tumor was spread out between the muscle fibres of the diaphragm. These two tumors are, therefore, called diaphragmatic lipomas. They might also be called subpleural lipomas. In the cases of Sauerbruch and Fitz, the tumors were attached to the pericardium suggesting that they arose from the pericardial fat. Fitz, however, designates his case as one of congenital intrapleural lipoma. In the case of Chiari the tumor is stated to have lain between the costal pleura and the endothoracic fascia. It is called, therefore, a subpleural lipoma. In the eleven remaining cases the only statements referring to the origin of the tumor lead me to believe that they arose in the mediastinum; in the anterior mediastinum in nine cases and in the posterior mediastinum in two cases. Surveying the entire series of twenty-eight cases it will be seen that the thoracic lipomas thus far reported are, with two possible exceptions, all mediastinal in origin or, at least, occupy the mediastinum; and there is evidence which suggests that many of them are congenital.

SUMMARY.—A summary of the preceding pages may be given as follows:

(1) A study of the literature shows that twenty-eight cases of lipoma involving the thorax are recorded. To this number I am adding a case, remarkable chiefly because of its size.

(2) The thoracic lipomas as reported may conveniently be described in three groups, a group in which an intra- and extrathoracic tumor is connected by a narrowed isthmus which occupies a perforation in the thoracic wall; a group in which a mediastinal tumor extends upward into the neck; and a group in which the tumor lies entirely within the thorax.

(3) Of the twelve cases falling into the first two groups (presenting external tumors) eleven were subjected to operation, and one died untreated of mediastinal compression symptoms. Of the eleven cases operated upon, seven recovered after the complete removal of the tumor and were cured; and four died. The four deaths resulted from infection and occurred in a period before the development of aseptic surgery.

(4) Of the seventeen cases (including that herein reported) in which the tumor was entirely intrathoracic, in only six was a positive diagnosis of intrathoracic tumor made before operation or necropsy; in only one a positive diagnosis of intrathoracic lipoma (my case, biopsy). In many of the cases the failure to diagnose tumor was in part due to the presence of complicating conditions which confused the clinical picture; in part to the failure of X-ray examinations. Of the seventeen cases, fourteen died untreated, and three were subjected to operation. The three cases subjected to operation recovered after the removal of the tumors, and were cured.

(5) The intrathoracic lipomas have in some instances developed into

tumors of great size. The case of Leopold (seventeen and one-half pounds) is the largest intrathoracic tumor I have found recorded. It is evident from the case histories that some of them may reach great proportions before giving rise to serious pressure symptoms; and that some have grown very slowly. Their origin is somewhat problematical. Of twenty cases (exclusive of the hour-glass tumors) in which the tumor was entirely intrathoracic (seventeen), or presented at the root of the neck (three), the tumor apparently had its origin in the mediastinum in seventeen, and in the subpleural space in three. Of the nine cases of hour-glass tumor, the intrathoracic part of the tumor occupied the mediastinum in eight, the subpleural space in one. There is some evidence that the thoracic lipomas are congenital tumors; in the hour-glass variety, because of the early appearance of some of the recorded cases, the difficulty of otherwise explaining their form and direction of growth, and the analogy with other tumors in the body; in the intrathoracic variety because of the hypoplasia of the lung and heart, especially well illustrated by the cases of Fitz and me, and the evident duration of symptoms.

A summary of the cases reported in the literature follows.

GROUP I—Hour-Glass Tumors

CASE I.—CRUVEILHIER, J. (*Traité d'Anatomie pathol. generalis*, vol. iii, p. 315. Ballière et fils, Paris, 1856.) There are but few details of this case. The author states that a patient presented a fatty tumor over the sternum which was operated upon. The surgeon found on surrounding the tumor that it gave off several prolongations at the lateral border of the sternum which penetrated the thoracic wall and connected with an anterior mediastinal tumor. The external tumor was removed and the prolongation through the thoracic wall partially delivered by traction on the external tumor. The mediastinal tumor was not removed. The patient developed a suppurative inflammation in the anterior mediastinum and died.

CASE II.—CZERNY, J. G. (*Wien. Med. Wchnschr.*, vol. xxv, p. 166, 1875.) The patient was a white male, eighteen years of age, and a waiter by occupation who complained of a tumor on his back, pain in the left axilla and dyspnoea. He had always been well until three years previous to his appearance when he injured his back. Following the injury a tumor appeared on his back which has grown rapidly. Physical examination showed a well-developed man who presented below the left scapula a tumor the size of a "man's head." Its surface was smooth, the skin over it not attached. The tumor was aspirated but no fluid obtained. The pre-operative diagnosis was lipoma. At operation the external tumor was surrounded and found to be continuous with a pedicle which perforated the seventh intercostal space through an opening the size of a hen's egg. The intrathoracic portion of the tumor was freed with the finger and removed in fragments; the combined fragments representing a tumor the size of a "fist." Following operation the patient developed an infection and died the fourth post-operative day. The autopsy showed an cedematous, bloody lung and a purulent pleurisy.

CASE III.—VOGT, CARL. (*Dissertation*, Berlin, 1876. This case is also referred to in the literature as Krönlein's or Langenbeck's.) The patient was an infant, one year old, who was brought to the clinic because of an apparently painless tumor over the right anterior thorax. The tumor was first observed six months previously and had grown rapidly. On examination the child was slightly undernourished. The external tumor was large extending from just below the clavicle to the xiphoid and in breadth extending from two finger-breadths to the left of the sternum to the right axilla. It measured nine centimetres long, three centimetres in height and 15.5 centimetres in cir-

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cumference. The skin over the tumor was freely movable; the tumor itself was soft and slightly lobulated. There was dullness on percussion of the thorax about the tumor and faint breath sounds. An X-ray was not taken. At operation the external tumor was freed and found to narrow to a pedicle which perforated the third intercostal space one centimetre to the right of the sternum. The external tumor only was removed and grossly and microscopically was diagnosed a lipoma. On the fifth day after operation the patient developed a temperature of 104° F. and the pulse rose to 200. Extreme dyspnoea appeared and the patient died on the eighth post-operative day. The condition was called erysipelas. The autopsy showed a large mediastinal lipoma extending from the manubrium to the xiphoid and measuring eleven by ten by 8.5 centimetres in diameter. The heart was dislocated to the left and posteriorly. There was a purulent pleurisy and pneumonia.

CASE IV.—PLETTNER, G. A. L. (Inaug. Diss., Halle, 1889.) The case was that of an elderly white woman who presented a tumor over the left thoracic wall. Details regarding the patient are lacking. At operation the external tumor narrowed to a

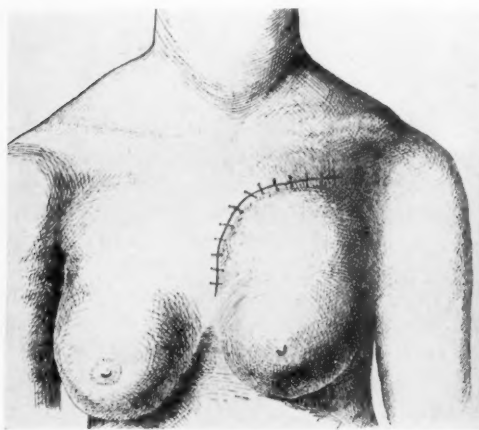


FIG. 6.—Gussenbauer's case showing external tumor presenting under the left breast and the incision used in its exposure.

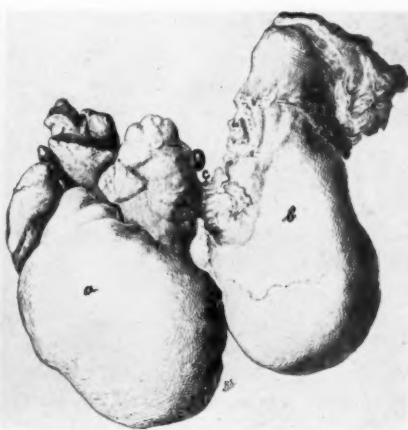


FIG. 7.—Gussenbauer's case showing the external portion of the tumor (a); the intrathoracic portion of the tumor (b); the isthmus (c).

pedicle which perforated the thoracic wall in the axilla between the fourth and the fifth ribs. The external tumor only was removed and was diagnosed a lipoma. Following the operation the patient developed an inflammation of the pedicle of the tumor and died. At autopsy a "subpleural" lipoma was found continuous with the pedicle of the external tumor. There was a septic pleurisy and pericarditis.

CASE V.—GUSSENBAUER, CARL. (Arch. f. Klin. Chir., vol. xliii, p. 322, 1892.) A white woman, forty-two years of age, complained of cough and swelling under her left breast. She was a healthy woman, the mother of four healthy children. Examination showed a tumor under the upper part of the left breast which extended out into the axilla. The tumor dislocated the breast forward, and was soft and elastic on palpation. It was somewhat larger than a "man's fist." On percussion about the tumor there was dullness which extended to the cardiac dullness. The heart and lungs appeared normal. At operation a curved incision was made around the upper border of the breast (Figs. 6, 7 and 8) and the external tumor exposed. It was covered by a delicate membrane or capsule which together with the pedicle of the tumor extended through the second intercostal space into the thorax. The opening was enlarged by the resection of the third costal cartilage, the intrathoracic tumor freed with the finger and withdrawn from the chest. The pleura was not injured. The wound was drained. After a rather stormy

three-weeks' convalescence characterized by fever and the retention of blood-clots in the wound the patient completely recovered. The tumor weighed 500 grams and was apparently covered by the endothoracic fascia. It was this finding which led Gussenbauer to believe that the tumor originated in the subpleural space and extended outward through the intercostal space.

CASE VI.—GARNIER, C., ET GROSJEAN, L. (*Rev. Med. de l'est*, vol. xxxv, p. 654, 1903.) A white man, aged fifty-six, presented himself complaining of pain of three months' duration in and about the sternum. This pain called to his attention a small swelling over the sternum which had been sensitive to pressure. The man otherwise was perfectly well. Excepting for pain there were no symptoms referable to the tumor. Examination showed a tumor the size of an "egg" situated over the xiphoid in the median line. The skin was freely movable over it. The tumor was soft, slightly fluctuant, and painful on palpation. Aspiration of the tumor failed to reveal fluid. The physical examination otherwise was negative. At operation a lobulated tumor was found which extended, by means of a narrow pedicle through the sternum, into the

anterior mediastinum. The mediastinal portion of the tumor was delivered through this opening. The patient made an uninterrupted recovery. The tumor was a lipoma.

CASE VII.—HARMS, CLAUS. (*Zeitschr. f. Chir.*, vol. xlvii, p. 668, 1920.) The case was that of a farmer, aged fifty-three, who complained of a swelling over the right anterior thorax. The swelling had been present two years, was increasing rather rapidly in size and had caused considerable pain. There were no other symptoms present. On examination the tumor appeared to be the size of a "small apple," lay to the right of the sternum at the level of the second rib, was soft, fluctuant and immovably fixed to the thoracic wall. Physical examination

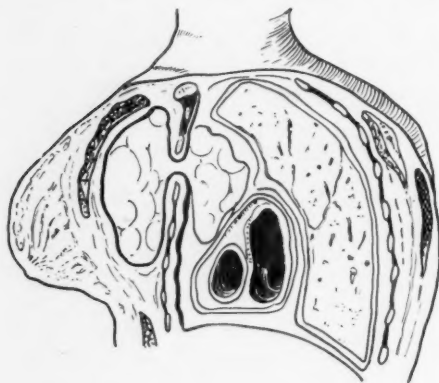


FIG. 8.—Semi-diagrammatic section of thorax showing the relationship of the tumor in Gussenbauer's case.

otherwise was negative. The X-ray failed to show a shadow in the chest. The tumor was aspirated with negative results. A diagnosis of subfacial lipoma or sarcoma was made. At operation a lipoma was found lying largely under the major pectoral muscle having a pedicle as large as one's thumb which extended into the mediastinum through an opening in the second intercostal space. The mediastinal portion of the tumor was small and was shelled out without difficulty. The patient made an uninterrupted recovery. The tumor is called a subpleural lipoma.

CASE VIII.—BEYERS, C. F. (*Lancet*, London, vol. i, p. 283, 1923.) The patient was a male child, twenty-two months old, who came under observation because of a swelling over the anterior thoracic wall. The tumor had been present for a year and had been growing rapidly. Examination showed a sturdy child, rather pale, but quite healthy, who presented a lobulated, fluctuant tumor, two inches in diameter, to the left of the sternum over the fifth, sixth and seventh costal cartilages. The physical examination otherwise was negative. A diagnosis of cold abscess from a tuberculous rib was made. At operation, an incision parallel to the sixth rib exposed a lipoma possessing a pedicle which penetrated the thoracic wall in the 6th interspace. The sixth and seventh costal cartilages were resected and the mediastinal tumor removed. The tumor on removal presented a typical dumb-bell shape. The patient made a satisfactory recovery.

CASE IX.—WALZEL, P. (*Arch. f. Klin. Chir.*, vol. clxx, p. 112, 1932.) A white male child, fifteen months of age, came under observation because of a tumor in the right

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axilla. His mother had first discovered the tumor six months previously and stated that it had grown rapidly in size. At first this tumor was without symptoms. Later there developed dyspnea and slight cyanosis. The child was under observation three months before being admitted to the hospital and during this period the tumor and the symptoms both increased. Examination showed a tumor in the right axilla the size of a "mandarin" which was not adherent to the skin but was immovably fixed to the thoracic wall. The physical examination of the chest is not reported. The X-ray showed a large shadow in the right chest and a widening of the right third and fourth intercostal spaces. Aspiration of the external tumor did not yield any fluid. A biopsy was done upon the external tumor and a diagnosis of lipomyxoma was made. At operation the external tumor was freed and as usual in these cases a narrowed pedicle was found which extended through the third intercostal space. The external tumor was removed, after which sections of the third to the fifth ribs were resected. The intrathoracic portion of the tumor was found to be adherent to the pleura and in its removal the pleura was torn. The entire tumor, however, was successfully removed. The patient made an uneventful recovery. The tumor after removal was of the typical hour-glass shape, the external portion weighing 160 grams, the internal 240 grams. The pedicle was the thickness of a "thumb."

GROUP II.—*Anterior Superior Mediastinal Lipomas Presenting at the Root of the Neck*

CASE I.—BEATSON, G. T. (Glasgow Med. Jour., vol. li, p. 57, 1899.) The patient, a white man forty-five years of age, came under observation because of a tumor of the neck which presented above the manubrium sterni. The tumor had been present for five years, and during this period had grown steadily in size. There are no comments to indicate that the tumor had caused any noteworthy symptoms. The physical examination is not recorded. The tumor was diagnosed a cyst of the mediastinum. At operation (collar incision) the tumor was found to be a lipoma, the size of an "orange," which extended downward into the mediastinum. It was freed and delivered. The patient recovered. Pathologically the tumor was diagnosed a lipoma, although Mr. H. E. Clark thought it might contain elements connected with the thymus gland.

CASE II.—LEMON, W. S. (Med. Clin. N. Amer., p. 1247, January, 1925.) The patient, a minister aged forty-six, came to The Mayo Clinic complaining of dyspnea, swelling of the neck, paroxysms of coughing and hemoptysis. His symptoms were of five years' duration, and a previous diagnosis of enlarged thyroid gland with pressure symptoms had been made. Examination showed an obese man with an evident supra-clavicular tumor mass five centimetres in diameter. There was no bulging of the thoracic wall and no signs of mediastinal pressure. There was mediastinal dullness to the right, diminished excursion of the right thorax and distant breath sounds over the entire right side. The X-ray film showed a large, lobulated mediastinal tumor extending into the right thorax. Bronchoscopic examination was negative. A biopsy (supra-clavicular tumor) showed a simple lipoma. The patient was given radiotherapy and discharged. His symptoms continued to increase and he developed marked dyspnea, cyanosis and paroxysms of coughing. He died two years after leaving the clinic. Autopsy showed a mediastinal lipoma larger than a "quart cup" adherent to the trachea, aorta and right bronchus and extending well into the right thoracic cavity.

CASE III.—GRAHAM, E. A., and WIESE, E. R. (Arch. Surg., vol. xvi, p. 380, 1928.) The patient, a white man forty-three years of age, complained of a swelling of the neck, pain in the neck and chest, choking spells and dyspnea. The swelling of the neck had been present for six months and had increased in size. Examination showed a robust man with a diffuse swelling above the sternum, more to the right than to the left of the midline, which apparently extended downward into the superior mediastinum. The mass was immovable and not tender. There was no substernal dullness. There was some hoarseness, and some cyanosis of the finger tips. An X-ray film of the chest failed

to show any abnormality excepting a high right diaphragm suggestive of a partial paralysis. Examination of the larynx showed the left vocal cord more active than the right. Under local anaesthesia and through a "collar" incision a tumor measuring nine by five centimetres in diameter and extending four centimetres into the anterior mediastinum was delivered and removed. Pathological examination showed a lipoma. The patient recovered with the prompt disappearance of the hoarseness and dyspnoea.

GROUP III.—*The Intrathoracic Lipomas*

CASE I.—FOTHERGILL, JOHN. (Collected Works, London, 1783, p. 509, J. Walker. Cited by Hare, Hobart, Pathology, Clinical History and Diagnosis of Affections of the Mediastinum, London, 1883.) The case is incompletely reported. It concerns a man with symptoms of angina pectoris who died without a diagnosis of intrathoracic tumor having been made. At necropsy a lipoma of the mediastinum was found which was adherent to or involved the pericardium.

CASE II.—JURINE, LOUIS. (Traité de l'angine de poitrine. Appendix, Case IV. J. J. Pachoud, Paris, 1815.) A white man, fifty years of age, who complained of faintness and dyspnoea died and at necropsy presented a lipoma which filled the entire anterior mediastinum. The microscopical diagnosis was lipoma.

CASE III.—SCHREIBER, A. (Deutsch. Arch. f. klin. Med., vol. xxvii, p. 52, 1880.) The patient was a white man thirty-eight years of age who had fever, dyspnoea and cyanosis of the face of one month's duration. The patient died and at autopsy showed a lipoma of the mediastinum, bloody fluid in the pericardium and a hæmorrhagic exudate in the pleural cavity. The size of the lipoma is not given. The case is used by the author as a demonstration of the difficulties in differential diagnosis of intrathoracic conditions. The death he attributes to pericarditis. The case is reported by Hare in his monograph.

CASE IV.—CLARK, F. W. (Path. Soc. Lond., vol. xxxviii, p. 324, 1887.) A white woman sixty-five years of age sustained an intracapsular fracture of the neck of the femur, from the effects of which she died. At necropsy a rounded lobulated tumor, the size of a "goose egg," was found projecting into the right pleural cavity. There were no adhesions between the pleura and the tumor. The base of the growth spread out between the muscle fibres of the diaphragm. The author remarks: "With reference to this specimen I would venture to state that there is normally an outgrowth of fat from the diaphragm situate on the right side anteriorly close to the reflection of the pericardial pleura on to the diaphragm. This may, in cases of general obesity, become occasionally so increased in amount as almost to assume the appearance of a fatty tumor, but does not of course constitute a true tumor since it is but part of a general physiological process."

CASE V.—CHIARI, O. (Cited by Gussenbauer; Arch. f. klin. Chir., vol. xliii, p. 322, 1892.) A woman aged sixty-two died of Bright's disease and endocarditis, and came to necropsy. An intrathoracic tumor was not suspected during life. At the post-mortem examination a subpleural lipoma the size of a walnut was found lying near the left seventh rib and projecting into the thoracic cavity. The tumor lay between the costal pleura and the endothoracic fascia.

CASE VI.—CONNER, L. (Proc. N. Y. Path. Soc., 1897, p. 43.) An old woman whose age is not stated died of cerebral hæmorrhage and the intrathoracic lipoma was an unexpected necropsy finding. The tumor was situated to the left and posterior to the cardiac apex, measured four by three centimetres in diameter and was covered by the diaphragmatic pleura. Doctor Conner suggested that it had its origin from the diaphragm and extended into the pleural cavity.

CASE VII.—FITZ, REGINALD. (Am. Jour. Med. Sci., vol. cxxx, p. 785, 1905.) A fisherman, aged thirty-four, came under observation complaining of pain in the chest, cough with rusty sputum, and dyspnoea. He had been acutely ill for fourteen days and had had a chill ten days before admission. His temperature was 104°, his pulse 145, his

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respirations 50 and his leucocytes 41,200. Physical examination showed dullness over the lower right axilla with absence of respiratory and vocal sounds. A diagnosis of lobar pneumonia was made. The patient subsequently developed signs and symptoms of pericarditis and the pericardial sac was aspirated without obtaining fluid. The patient died on the twenty-first day of his illness. At necropsy the pericardial cavity contained 500 cubic centimetres of opaque yellowish fluid. Attached to the pericardium on the left was a large mass of fat divided into lobules. It was attached to the pericardium, diaphragm, pleura and inferior lobe of the left lung. This lobe was but one-third its normal size, dark red in color and apparently hypoplastic. The final diagnosis was intrapleural lipoma. Its congenital origin in the author's opinion was indicated by the hypoplasia of the left lower lobe.

CASE VIII.—BERTOLI, P. (*Gazz. de Osp.*, vol. xxix, p. 1108, 1908.) A man aged fifty-nine who died of empyema of the right thorax. He failed to present any signs of an intrathoracic tumor. At necropsy a large lobulated lipoma was found in the mediastinum.

CASE IX.—GARRÉ, C. (*Deutsch. med. Wchnschr.*, vol. xlv, p. 617, 1918.) A white woman, twenty-eight years of age, came to the author complaining of pain in the chest, difficulty in breathing and swallowing and hoarseness. A previous diagnosis of pulmonary tuberculosis had been made and she had taken a "cure" at a sanatorium. Physical examination showed dullness over the right apex, and an X-ray showed an intense spherical shadow filling the right apical region and extending downward to the sixth rib posteriorly. A diagnosis of intrathoracic tumor was made. The patient was subjected to operation and the tumor completely removed through a posterior approach. It lay within the mediastinum and was adherent to the pleura. On removal the tumor measured eight by ten centimetres in diameter, and weighed 270 grams. The pathological diagnosis was fibrolipoma. The patient recovered.

CASE X.—AUVRAY, M. (Cited by Garré. *Deutsch. Med. Wchnschr.*, vol. xlv, p. 617, 1918.) The original reference to this case could not be found. Garré does not give any details of the case. He states simply that Auvray had a case of lipoma of the mediastinum.

CASE XI.—LEOPOLD, R. S. (*Arch. Int. Med.*, vol. xxvi, p. 274, 1920.) A white man, aged thirty-seven and one-half years, complained of persistent cough, pain in the chest, dyspnoea and substernal oppression. His symptoms were of twenty years' duration beginning with cough, followed by thoracic pain and dyspnoea. Eventually he was unable to breathe in the recumbent position and suffered continuously from dyspnoea. Examination showed a man who had lost a great deal of weight and who had continuous air hunger, cyanosis of the head, face and arms, and oedema of the abdomen, genitalia and lower extremities. The anteroposterior X-ray of the thorax showed a dense shadow extending from the third rib to the diaphragm and filling the entire thorax except for a small area on the lower right side. The lateral X-ray showed a similar enormous mass filling the thorax. The patient died with extreme symptoms of mediastinal compression. The necropsy showed a huge lipoma of the anterior mediastinum measuring thirty-one by thirty by fifteen centimetres, and weighing seventeen and a half pounds. It was attached just below the sternal notch. The heart, great vessels and lungs were compressed against the vertebral column and displaced downward. The heart was small and atrophic as in my case. The abdomen was filled with exudate, the viscera congested. The lower extremities were extremely oedematous.

CASE XII.—SAUERBRUCH, F. (*Chirurgie d. Brustorgane*, vol. ii, p. 376. Julius Springer, Berlin, 1925.) A patient whose age and sex are not stated complained of cardiac symptoms and on physical examination was found to have a tumor of the anterior mediastinum. At operation the third costal cartilage was resected and the tumor enucleated without opening the pleura. The pathological diagnosis was mediastinal lipoma. The patient recovered.

CASE XIII.—YATES, WALLACE M., and LYDDANE, E. STEWART. (*Amer. Jour. Med. Sci.*, vol. clxxx, p. 79, 1930.) The patient was a carpenter, aged forty-four, who had suffered from dyspnoea on exertion since an attack of influenza in 1918. Two days before he consulted the authors he became acutely ill with symptoms of pain in his lower left chest, cough and expectoration of mucoid, blood-streaked sputum. On admission he was dyspnoeic, had pain in his chest, cough and blood-streaked sputum. His temperature was 102°, pulse 120, respirations 28, and leucocytes 15,750. On physical examination there was flatness on percussion over the right lower thorax with diminished breath sounds and crackling inspiratory râles throughout the lungs. The X-ray of the chest showed a dense opacity of the lower two-thirds of the right chest and an opacity of the lower portion of the upper lobe. The sputum showed the pneumococcus, type 4. A diagnosis of pneumonia was made. The patient died on the fourth day after admission. At necropsy the right lung was completely consolidated and but one-third the normal size. The heart appeared normal. Occupying the anterior mediastinum and largely filling the right side of the thorax was a large, yellowish tumor, twenty-eight centimetres long and weighing eight and a half pounds, which on gross and microscopical examination was a pure lipoma.

CASE XIV.—EWING, JAMES. (*Neoplastic Diseases*, p. 199. W. B. Saunders Co., Philadelphia, 1931.) A middle-aged white man who at necropsy presented a mediastinal lipoma encircling nearly all the structures of the thorax and made up of five main lobules each the size of a "goose egg." The tumor arose in the anterior mediastinum and filled one-half of the left pleural cavity.

CASE XV.—KLEMPERER AND RABIN. (*Arch. Path.*, vol. xi, p. 385, 1931. (Fourth case.) A white man, forty-one years of age, was admitted to Mount Sinai Hospital September 6, 1919, complaining of pain in the right side of the chest. He was dyspnoeic and on physical examination presented the signs of fluid in the right chest. X-ray examination showed a large shadow almost completely filling the right side of the thorax which was interpreted as due to a neoplasm. He left the hospital to return after a lapse of eleven years (1930). His symptoms had increased and on his second admission he was intensely cyanotic and dyspnoeic and showed an enlargement of the liver and œdema of the lower extremities. He died of cardiac failure. At necropsy there was noted marked cyanosis of the head and neck and slight clubbing of the fingers and toes. The right side of the thorax was filled with a soft tumor mass, larger than a man's head, which was adherent to the parietal pleura of the anterior and lateral walls of the chest. In shape it was like a cast of the right pleural cavity. It apparently had its origin in front of the right lower lobe; its base rested on the diaphragm; and its upper pole crowded the middle and upper lobes into the dome of the pleura. The pericardial sac did not contain any fluid. The heart weighed 480 grams. Microscopical examination of the tumor showed the typical structure of a lipoma.

CASE XVI.—RUETZ, A. (*Zentralb. f. Chir.*, vol. lix, p. 41, p. 2477, 1932.) Details of the case are not given. The patient was a young man who had a tumor of the posterior mediastinum causing displacement of the heart and disturbance of the cardiac rhythm. This was removed through a posterior approach and proved to be a lipoma the size of two fists. The patient recovered.

ADDENDUM.—Since the paper has been written the following two cases have been found in the literature. The one case (XVII) belongs with the group of intrathoracic lipomas, the other case (XVIII) belongs to the superior mediastinal lipomas presenting at the root of the neck.

CASE XVII.—NARR, FREDERICK and WELLS, ARTHUR. (*Am. Jour. Cancer*, vol. xviii, No. 4, p. 912.) The case was that of a man of thirty-three, a laboratory assistant, who had fallen and injured the lower left ribs. Subsequently the patient developed the symptoms of an intrathoracic tumor. His dyspnoea became so marked that operation

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seemed advisable. At operation the intrathoracic tumor was exposed and as much of it as possible was removed. Post-operative X-ray therapy failed to retard the further growth of the tumor and the patient died five years after the initial injury with a tumor which filled the entire left pleural cavity.

At the necropsy a large intrathoracic mass was immediately seen bulging above the removed breast plate, the mass filling the entire left thorax and approximately the anterior half of the right thorax, forcing the diaphragm down and filling the upper left quadrant of the abdomen. It was quite easily shelled out and was found to be completely encapsulated by a thick fibrous capsule over its entire surface, except about the mediastinum. It was closely adherent to the diaphragm. In places the capsule was torn through and soft, light brown mucoid matter flowed from these areas. The tumor showed three types of tissue, a thick fibrous capsule, adipose tissue and myxomatous tissue. The size and weight of the tumor are not given.

CASE XVIII.—FITZWILLIAMS, DUNCAN C. L. (Proc. Roy. Soc. Med., vol. vii, Sect. Stud. Dis. Child., p. 19, London, 1913-1914.) The author describes the case of a child of six who was seen in January at which time there was a tumor found in the neck and chest which was diagnosed a hernia of the lung. A truss was applied, but by September the tumor had grown so that operation was decided upon. The whole mass was removed and proved to be lipoma with little fibrous tissue. The portion in the neck communicated by means of a narrow isthmus passing down behind the subclavian artery with a much larger portion which lay within the thorax outside the parietal pleura. The tumor was soft; coughing impelled the intrathoracic portion into the neck. The tumor was removed as a whole, and it measured four and three-quarter inches long and about four inches high. The result is not definitely stated but it is presumed that the patient recovered.

THE TREATMENT OF INTERCOSTAL NEURALGIA OF THE ABDOMINAL WALL

BY JOHN BERTON CARNETT, M.D., AND WILLIAM BATES, M.D.

OF PHILADELPHIA, PA

FROM THE GRADUATE SCHOOL OF MEDICINE OF THE UNIVERSITY OF PENNSYLVANIA

IRRITATION of any one or more of the seven lower intercostal and first lumbar nerves is a frequent cause of pain and tenderness in the anterior abdominal wall and is commonly mistaken for any one or more of the various intra-abdominal lesions which have pain and tenderness as their outstanding symptoms.

In a series of papers,¹⁻⁷ one of us has described how neuralgic pain and tenderness of the anterior abdominal wall may simulate acute or chronic appendicitis, biliary or renal disease, gastric or intestinal lesions, inflammation of the uterine adnexa, peritonitis and various other lesions. In these earlier papers the methods of differentiating between parietal and intra-abdominal tenderness were given in great detail. Briefly, parietal tenderness is always found to persist on vigorous palpation made while the patient balloons out his abdomen and voluntarily holds his abdominal muscles so tense that the examiner's fingers cannot possibly come in contact with the abdominal viscera. In about 95 per cent. of cases of parietal tenderness hypersensitiveness is also easily demonstrated by pinching a liberal fold of abdominal skin and fat.

When these simple tests are applied in every instance of abdominal pain or tenderness it is found that the symptoms are parietal in location and not visceral in origin in over 50 per cent. of the patients.

Intercostal neuralgia of the abdominal wall is due to a great variety of causes and may occur in chronic, acute, remittent or relapsing form. Chronic neuralgia is due most commonly to excessive lumbar lordosis, scoliosis or spinal arthritis.

Exaggerated lumbar lordosis is the most frequent direct cause of chronic neuralgia as well as the common predisposing cause of acute, recurrent and remittent neuralgia of the abdominal wall at all ages but particularly so prior to the age of thirty-five years. Some of our views on lordosis are set forth in a paper on "Chronic Strain of the Lumbar Spine and Sacro-iliac Joints."⁸

Normally there is a moderate degree of lordosis in the lumbar spine. With a patient standing with his heels four inches from the wall and with his pelvis, shoulders and head touching the wall, the normal forward curve barely permits insertion of the examiner's flat fingers between the lumbar spine and the wall. In extreme lordosis there is sufficient space to accommodate the examiner's fist. Only a slight accentuation of the forward lumbar curve may result in sufficient pressure on the nerves at the intervertebral foramina to cause neuralgic pain and tenderness of the abdominal wall.

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Parietal neuralgia, however, is usually encountered in the more severe grades of lordosis and the latter are frequently associated with round shoulders. Excessive lumbar lordosis is found in the asthenic, visceroptotic type of individual and is but one of the many abnormalities found in this form of bad body mechanics. The treatment of chronic neuralgia is directed toward correction of the bad body mechanics by the special exercises developed by Goldthwait and his colleagues and described by Thomas⁹ and by Cochrane.¹⁰ Primarily the exercises are directed toward strengthening the abdominal and buttock muscles and the individual must be taught to utilize these muscles in maintaining proper posture until the latter becomes habitual. In badly undernourished individuals active exercises may have to be held in abeyance until the patient gains weight and strength by forced feeding, but help meanwhile may be obtained by recumbency in positions favorable for correcting deformity and by wearing a suitable brace. (Cochrane, chapter three.) A gain of twenty-five pounds in weight in itself may cause disappearance of neuralgic symptoms in the undernourished, probably due to improved tone of muscles and consequent lessening strain on the spine and its ligaments.

In addition to overcoming the excess lordosis and the neuralgic abdominal pain, the exercises increase the chest capacity and raise ptosed abdominal viscera as we have described elsewhere.¹¹⁻¹³ Our patients with abdominal neuralgia are mainly adults with bad body mechanics. We are hoping that the views expressed in the White House Conference report on Body Mechanics¹⁴ will result in prevention or correction of bad body mechanics in childhood with a marked amelioration of the hollow back, round shoulders, sunken chest, visceroptosis, abdominal neuralgia and chronic invalidism in adults.

When scoliosis causes neuralgia the nerves involved usually come off on the side of the concavity. In frank cases of compensating S-curve it is not uncommon to find neuralgic symptoms in one lower quadrant of the abdomen and in the opposite upper quadrant of the chest. Shortening of one leg, generally of moderate degree, is a frequent finding and should be sought for in every case of scoliosis and if found should be corrected by elevation of the heel of the shoe on the short side. In our opinion equalizing the length of the two lower extremities is an essential preliminary to overcoming the scoliosis and in itself frequently abolishes pain of many months' or years' duration. With a C-curve of the spine a low shoulder will be found on the same side as the short leg but with an S-curve the low shoulder is usually found on the opposite side. When the spine is supple simple heel elevation in itself in S-scoliosis may completely equalize the height of the shoulders, correct the milder grades of scoliosis, and overcome the parietal pain and tenderness. In C-scoliosis unilateral bending exercises are necessary to bring the shoulders to the same level.

Scoliosis is frequently associated with excessive lumbar lordosis and the exercises employed for the latter commonly correct postural scoliosis. In transitional scoliosis, however, the lordosis exercises need to be supplemented by special bending and rotating or even hanging exercises. Scoliosis with

structural changes calls for orthopædic treatment which is beyond the scope of this paper to describe. In many of the most extreme cases of scoliosis there are commonly no neuralgic symptoms due probably to long-standing adjustment of the vertebræ to the changed conditions and consequent lack of inflammatory irritation in the region of the intervertebral foramina. This tendency to ultimate spontaneous disappearance of neuralgic pain and tenderness of the abdominal wall is frequently noted also in patients with exaggerated lumbar lordosis or with spinal arthritis.

Parietal pain with spontaneous recovery is the most plausible explanation for those cases in which the original abdominal pain and tenderness persist for a year or longer following intra-abdominal operations and then disappear. This situation is well illustrated in the follow-up investigation of the results of gall-bladder operations by Stanton¹⁵ who found in one group in which the pathological changes in the gall-bladder were indefinite that "all reported cured or satisfactorily improved at the time of the last end-result note but in none of these cases can I demonstrate a cause and effect relationship between the operation and the final result. Either final recovery took place months or years after the operation, or there have been intervening recurrent attacks of symptoms indistinguishable from those for which the patient was operated on."

In the later years of life lumbar lordosis and scoliosis are relatively less frequent causes and spinal arthritis a more common cause of intercostal neuralgia of the abdominal wall.

Any form of spinal arthritis may cause neuralgia. Pressure on the intercostal nerve roots results from the extradural inflammatory exudate as described by Nathan.¹⁶ The neuralgic abdominal pain in somewhat over half of these cases is greatly benefited or abolished by a few mild applications of X-rays to that portion of the spine from which the affected nerves take their origin. About 15 to 20 per cent. of an erythema skin dose is employed four to six times at intervals of five to seven days. Some benefit is obtained by diathermia and massage applied to the same region. In acute arthritis rest of the spine is indicated whereas in chronic arthritis, particularly if body mechanics is bad, postural exercises are usually indicated. Treatment should be directed toward cure of the underlying arthritis as well as relief from the pain. We believe that any demonstrable toxic foci should be eliminated if possible, first, because they may be the cause of the arthritis and, second, because they impair the general health and resistance of the patient.

Because of the striking cause and effect relationship between acute toxæmia and acute neuralgia we fully expected to find a similar relationship between chronic toxæmia and chronic neuralgia but our experience has proven otherwise. The elimination of various forms of chronic toxic foci has only rarely had any direct effect in lessening the pain and tenderness of chronic neuralgia.

Franke, a writer on neuralgia of the abdominal wall whom we have quoted in another paper,⁷ sends us an urgent personal request to instruct the medical

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profession of America that chronic influenza is the usual cause of chronic neuralgia. We have complied with his request but we are not in accord with his opinion.

We have been amazed at the relative infrequency with which we have encountered syphilis as a cause of either chronic or acute neuralgia.

In the occasional neuralgias due to tuberculosis of the spine (Pott's disease), typhoid spine, tumor of the spinal cord or any form of spinal meningitis, treatment is directed toward the causative lesion. We have seen severe neuralgia disappear within an hour following blood transfusion in severe anæmias of the pernicious and secondary types. Many patients with mild chronic neuralgia seek our advice on the assumption they have appendicitis, cancer or some other intra-abdominal lesion but when reassured in those directions they elect to retain their mild pain and tenderness rather than take the time and trouble to eliminate them.

Patients with severe chronic neuralgia require some form of salicylates or other anti-neuralgic drugs to lessen their pains pending improvement in the underlying spinal condition. Fortunately, the vicious pain sometimes encountered in acute neuralgia is exceedingly rare in chronic neuralgia and we do not resort to morphine except when malignant disease which does not yield to irradiation presses upon or actually invades the nerves usually at or near the spine. Chronic neuralgia of the abdominal wall is a common cause of the morphine habit.

We have had some curious experiences with anæsthetization of intercostal and first lumbar nerves by injections of novocaine in chronic neuralgia. We aim to deposit about 3 cubic centimetres of 2 per cent. solution in the immediate vicinity of each affected nerve and we then need to wait five to ten minutes for the anæsthetic to take effect. Normally, the effect of the anæsthetic would be expected to pass off in an hour but not infrequently pain and tenderness which have been present for months or years disappear for one to many weeks or months even when the novocaine has been deposited around and not into the nerve. This effect never extends to non-anæsthetized hypersensitive nerves. Before resorting to section or alcohol injections of nerves we always try the effect of novocaine and if the latter gives prolonged relief we withhold the more drastic measures. When, as rarely happens, neuralgia affects only one intercostal or first lumbar nerve we commonly resort promptly to alcohol injection or to section of the nerve with avulsion of its distal end if novocaine gives only transient relief. We have not employed paravertebral alcohol injections. We do not employ section nor alcohol injections for more than three nerves. When, as commonly occurs, more nerves are involved we rely on other methods of treatment. Section or alcohol injection of the three most painful nerves in a more extensive area of chronic neuralgia is so often followed by increased pain and tenderness in adjacent nerves that we have practically abandoned employing them under these circumstances.

The majority of the chronic neuralgia patients, who habitually have their

most severe pain during the night or when they first awaken in the morning, are benefited by shifting to a different bed usually with firmer springs and mattress.

The more widespread the pain and tenderness of chronic neuralgia, the less likely are they to be benefited by any of the measures we have discussed except when they are due to spinal arthritis. We occasionally see a patient with hypersensitiveness of every spinal nerve on one side of the body and none on the opposite side. Their spontaneous pain is usually much more limited in extent. Possibly their trouble may be due to a toxæmia or other affection of a sensory tract in the spinal cord. We have not had much success in treating them. In one girl in particular, twenty-three years of age, we had numerous specialists examine the patient and we tried out every form of treatment suggested for eighteen months without improvement. Treatment was then stopped and after a few months spontaneous recovery occurred.

Another puzzling group of patients, often fat individuals, are those who are hypersensitive everywhere on the surface of the body indicating involvement of all the spinal and cranial sensory nerves although their spontaneous pain is much more limited. Some of these cases may belong to the type described as having a low threshold for pain whatever that may mean but the future is likely to disclose a better explanation for their universal tenderness. Some of them probably have an endocrine disturbance. In a few cases where the basal metabolic rate was elevated or depressed we have had success by treatment directed toward the thyroid dysfunction.

Evidence of ovarian or uterine endocrine disturbance is seen in many women with chronic neuralgia who have exacerbations before or during their menstrual periods. Their neuralgic pains and tenderness of the abdomen and thighs are often associated with similar symptoms in the breasts and scalp.

Premenstrual breast pains are commonly ascribed to congestion of the breast but in our experience neuralgia is the main factor. In the first place the pain and tenderness are not confined to the breasts but extend wide of them, often affecting the shoulder, neck, scalp and scapular region as well as the lower abdomen, buttocks and thighs. Pains in the breasts not infrequently persist in mild form between the exacerbations. Patients who have had a simple or radical amputation of the breast frequently have nearly or quite as much pain on the operated as on the non-operated side, and the nerve trunks from the upper dorsal spine to the breast regions are tender. These pains cease during the first day of the menstrual flow. Cutler¹⁷ has been successful in subduing premenstrual breast pains by the oral administration of ovarian residue. We have not had much experience with this remedy but our results have not been very brilliant. It is quite possible that some of the newer extracts to modify ovarian and uterine function may relieve premenstrual and menstrual neuralgia. Other endocrine preparations may prove helpful but as yet the whole subject of endocrinology is too vague for us to evaluate their importance in neuralgia.

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In our experience, both premenstrual and menstrual pains in the absence of pelvic organic disease occur chiefly in the viscerotonic type of women and respond best to corrective posture exercises and, when a short leg is present, to elevation of the heel. Thomas¹⁸ has found that of the Smith College students having dysmenorrhoea, but without local examination to determine its possible cause, the pains are abolished in 85 per cent. within three to four months after beginning vigorous posture exercises. In women approaching the menopause with severe exacerbations of neuralgic pain either before or during menstruation, irradiation of the ovaries may be considered as an effective means of preventing the neuralgic flare-ups.

Patients having acute, recurrent or relapsing attacks of intercostal neuralgia simulating various acute recurrent or relapsing intra-abdominal lesions almost invariably have as a predisposing cause one of the three spinal lesions commonly found in chronic neuralgia and have as an exciting cause an acute toxæmia from any cause, a spinal trauma, or menstrual disturbance. The predisposing spinal lesion often is adequate to cause a low-grade neuralgia giving mild abdominal tenderness only preceding an acute attack. The superadded acute toxæmia, spinal trauma or menstrual upset increases the nerve irritation to the point of producing acute pain and tenderness. Acute and recurrent attacks often precede the onset of chronic neuralgia. Acute exacerbations of the latter may then result from any of the causes which excite acute neuralgia.

Treatment of the acute attack of neuralgia consists in treating the underlying exciting cause. We have discussed premenstrual and menstrual forms of neuralgia.

Acute neuralgia of the abdominal wall may result from a variety of traumatic injuries in which the spine is jarred or twisted, or some part of it is fractured. We have discussed the traumatic form of diffuse neuralgia at considerable length in a paper on Railway Spine.¹⁹ Localized neuralgia involving one or two nerves may follow fracture of spinous processes by direct violence or fracture of one or two ribs. Traumatic neuralgia is the major factor in the spine injuries which form a big bone of contention in industrial and public liability compensation cases. The special tests for neuralgia in these cases would relieve the great majority of compensation claimants of the stigma of malingering. If traumatic neuralgia is severe the patient should be kept at rest in bed for two weeks or longer. Pillows may be arranged to begin correction of scoliosis or excess lumbar lordosis, and spinal irradiation should be employed in the cases of spinal arthritis. When the more acute symptoms subside, treatment is directed toward the underlying predisposing spinal cause by active exercises rather than by body casts or braces. Unrecognized parietal neuralgia is the usual cause of the localized or diffuse abdominal pain and tenderness following accidents for which patients are kept under observation for "possible internal injuries" which do not materialize. A relatively slight twist or jolt of the spine may result in severe and persistent neuralgia in patients having an antecedent chronic spinal

arthritis, scoliosis or excessive lumbar lordosis. Often the neuralgic symptoms do not appear until forty-eight hours after the accident. In these cases we believe the trauma aggravated the chronic inflammation with resulting soft tissue inflammatory exudate causing pressure on the intercostal nerve roots or nerves within the spinal canal or intervertebral foramina.

Acute neuralgia due to acute toxæmia occurs commonly on the second or third day of an acute follicular tonsillitis and only after one or often two weeks of the upper respiratory tract infection known as a common cold. Patients with severe follicular tonsillitis often deny having a sore throat hence examination is needed to reveal it and its associated tender, slightly enlarged lymph-nodes. The toxic neuralgia of a common cold may not manifest itself until a day or two after the patient believes his cold has "broken up" hence he does not volunteer information about having a recent cold and needs to be questioned thereon. Any acute toxæmia capable of producing fever may cause acute neuralgia. The underlying toxæmia causes fever, pulse hurry, and leucocytosis and when to these are added at the onset of neuralgia vomiting and acute pain and tenderness—the latter two affecting any one part or all of the abdomen—the analogy to diverse acute intra-abdominal lesions becomes apparent. In these acute cases the most important consideration is correct diagnosis. The parietal location of the acute neuralgic tenderness is readily recognized by pinching the skin and fat and by palpation over voluntarily tensed abdominal muscles, but its parietal location is easily mistaken for intra-abdominal tenderness with resulting diagnostic errors if these simple tests are not applied. The finding of acute parietal neuralgia, however, does not preclude the possibility of a coexistent acute intra-abdominal lesion. When the latter cannot be definitely excluded otherwise we abolish the parietal pain and tenderness by anæsthetizing the trunks of the affected nerves with injections of 2 per cent. novocaine. The intercostal nerve lies definitely below and not as is commonly believed in the subcostal groove of the superjacent rib. (Fig. 1.) In the early part of their course after emergence from the intervertebral foramina the intercostal nerves lie in such close relation to the pleura or peritoneum that injections are attended by the danger of the needle penetrating the underlying cavity with possible damage to viscera and failure to anæsthetize the nerve. This region should be especially avoided when an alcohol injection is employed to destroy a nerve. Between the anterior and posterior axillary lines the intercostal nerves lie superficial to the internal intercostal muscle in the chest or to the transversus muscle in the abdomen (Fig. 2), and with care can be anæsthetized or alcoholized without danger to the underlying structures. Injections of novocaine and of alcohol are made slightly anterior to the posterior axillary line for the intercostal nerves. The depth of the external intercostal muscle is best ascertained in fat patients and for the eleventh intercostal nerve by deliberately aiming the needle to hit the superjacent rib then depressing the point to miss the rib and inserting it about one-half inch deeper. The subcostal or twelfth intercostal is injected by striking the needle against the twelfth rib

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near its free end, then depressing the point and inserting it through the external and internal oblique to deposit the novocaine superficial to the transversalis. Exceptionally, by accident, the needle may strike the nerve in which event the patient experiences a stab of pain in its terminal distribution and only a few drops of novocaine are required to produce instant anæsthesia. Ordinarily no effort is made to strike the nerve by repeated probing as 3 cubic centimetres of 2 per cent. novocaine deposited near the nerve is adequate to cause anæsthesia in about five to ten minutes. Inasmuch as the insertion through the hypersensitive tissues of a blunt needle of large calibre is very painful a very fine needle is employed to produce a small skin wheal and then a very sharp pointed needle of slightly larger calibre is inserted through the wheal and novocaine may be injected through it on its

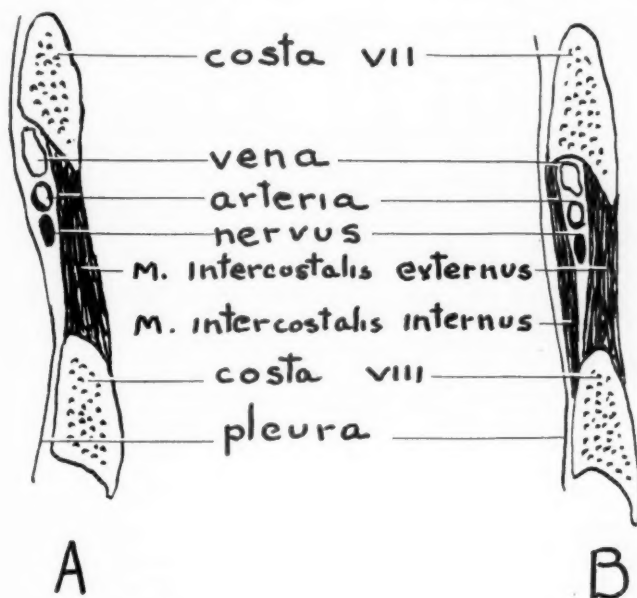


FIG. 1.—Relations of the intercostal nerve near the neck of the rib in A and slightly anterior to the posterior axillary line in B. (Courtesy of Professor Oscar V. Batson.)

way into the deeper tissues. When the lowermost abdomen is involved the ilioinguinal and the iliohypogastric nerves are both reached by one injection at a point (in adults) one inch away from the anterior superior iliac spine on a line toward the umbilicus. After inserting the needle through the skin the patient is instructed to hold the abdominal muscles tensed so that the surgeon can recognize more readily the slight jolt as the point of the needle passes through the aponeurosis of the external oblique. Three cubic centimetres of the novocaine solution is deposited between the external oblique and internal oblique.

The parietal tenderness must be abolished as shown by its absence on pinching and on vigorous palpation over tensed muscles before proceeding to examine for real subparietal tenderness. The latter is recognized by tender-

ness which is readily demonstrable by palpation over relaxed muscles and completely disappears on tensing the abdominal muscles. Subparietal tenderness is often due to chronic strain of the lumbar spine and the iliac fossa aspect of the sacroiliac joints and the tenderness will then be confined to them.⁸ Subparietal tenderness elsewhere is due to a visceral lesion or peritonitis.

Acute localized or diffuse neuralgia of the abdomen is frequently caused by the toxæmia of acute infections of the uterine tubes. Other intra-abdominal lesions cause a toxic neuralgia only very rarely. Except for acute pelvic infections it is comparatively rare for an acute attack of parietal neuralgia to coexist with any acute intra-abdominal lesion. The most com-

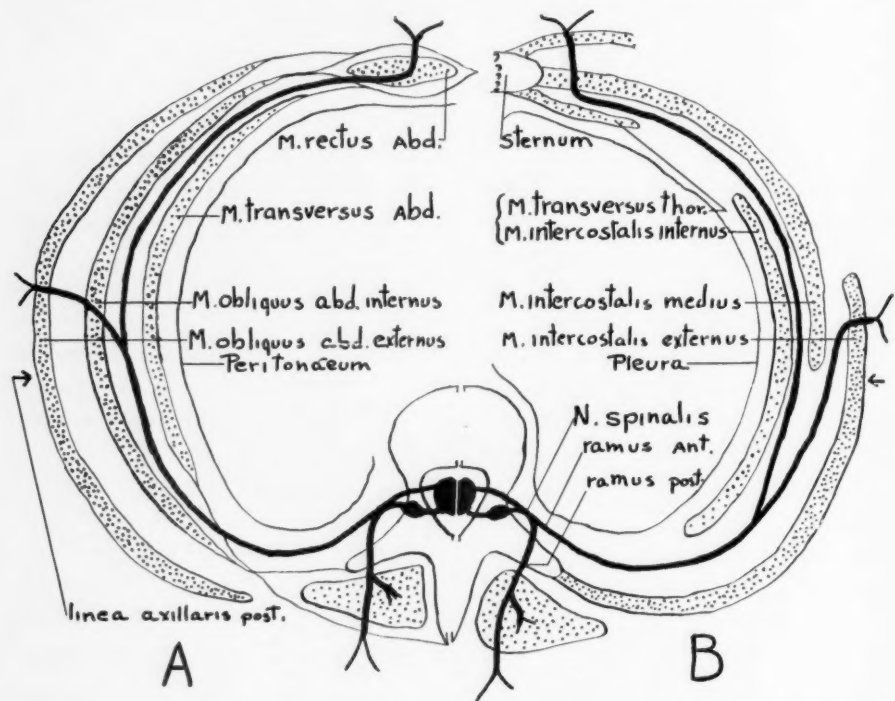


FIG. 2.—The intercostal nerve in relation to the structures of the abdomen in A and of the chest in B. (Courtesy of Professor Oscar V. Batson.)

mon associated acute lesion and yet a very infrequent one is acute appendicitis. That parietal neuralgia is not caused either directly or indirectly by appendicitis is proved by the persistence of the neuralgia for a few days following removal of an acutely inflamed or gangrenous appendix during the early stage in which the disease process is entirely confined to the appendix. In the absence of or with the induced disappearance of neuralgic pain and tenderness we have found the most reliable single sign of acute appendicitis to consist of tenderness which is present in the lower right quadrant when the abdominal muscles are relaxed and which is absent when they are tensed so that the examiner's fingers cannot touch the sensitive appendix. When

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this sign is negative and tenderness is absent on rectal examination we do not hesitate to refrain from appendectomy when fever, tachycardia, leucocytosis as high as twenty or thirty thousand, vomiting and abdominal pain and tenderness are present even though we are unable to find a local focus of acute infection.

Treatment depends upon whether or not an acute intra-abdominal lesion coexists with the acute parietal neuralgia. An acute pelvic infection calls for non-operative treatment whereas the exceptional other acute visceral lesions usually require operation. The toxic neuralgia itself calls for treatment appropriate to the underlying causative lesion. An abscess or cellulitis requires incision and drainage. We frequently use an intravenous injection of 20 cubic centimetres of Pregl's iodine for acute follicular tonsillitis which is usually due to a streptococcus infection. The ordinary cold is commonly in the terminal stage before neuralgia appears and as a rule does not require very active treatment. Basilar pleuropneumonia is a frequent source of acute neuralgia of the abdominal parietes and needs to be treated along the usual lines. In toxic neuralgias from any cause but particularly those in which the underlying infection cannot be determined eliminative treatment is indicated. Acute toxic neuralgia usually persists for only a few days and disappears rapidly after subsidence of the toxæmia.

Often the neuralgic pain is too mild to require special medication. Somewhat severer pain is relieved by anti-neuralgic drugs, by the local application of heat and by infra-red light treatment. Exceptionally the pain of neuralgia may be as severe as that seen in perforation or strangulation of a viscus²⁰ and must then be controlled temporarily if localized by novocaine injections of the affected nerves or if diffuse by heavy doses of morphine.

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WRINKLES AND RECIPES IN INTESTINAL SURGERY

BY CHARLES H. MAYO, M.D.

OF ROCHESTER, MINN.

THIS title may seem simple, but to write on both *why* and *how* would entail too much discussion of the principles of surgery of the intestine. I am writing, here, not for those filled with principles, or the why, but for those still interested in technic, or the how. After many years of surgical work, I believe that the essential principles of surgery are known and followed by most surgeons, but there is wide variation in the acceptance of risks, and in evaluating the probable benefit of operations in the presence of complications of serious import.

In order to evaluate probable immediate and late results of proposed surgical operations involving the intestines in the presence of complications which require immediate appraisal and judgment, an incision permitting of abdominal exploration would at least avert many serious operations, and would lower the operative mortality. However, when the abdomen is distended and obstruction is present, a large incision would be dangerous. In the presence of acute, right-sided abdominal distress and rigidity exploration may disclose a normal appendix, but there may be a generalized distribution of lymph and free fluid. Such a right-sided inflammation, in the presence of a normal appendix, should cause the experienced surgeon to suspect and search for a perforated peptic ulcer. If such a condition is present the escaped content flows around the hepatic flexure past the appendix, and never over the top of the transverse colon and omentum. If an acute ulcer is present, and the gall-bladder and appendix are also diseased, the two latter organs may be removed later. If cancer of the colon and cancer of the liver both are present, external colostomy should be avoided; if possible, the colon should be short-circuited around the tumor, or the tumor removed. Cancer of the liver is slow of growth, but gives rise to new tumors as long as the original growth is present. Death eventually will be caused by cancer of the liver, but life can be prolonged by preventing intestinal obstruction, and patients live from one to two years after developing symptoms; if the original growth is not removable, Röntgen therapy can be employed to check its activity.

As surgeons of wide experience observe the work of their confreres they base their impressions on the results secured, and on the ensemble of the little things, as well as the major things. Most of these little things are the accumulation of years of practical experience in the overcoming or avoiding of incident troubles. Some of the impressions are gained by observation of

sins of commission or omission of major importance, sometimes causing death, and others by observation of deficiencies of less importance but which cause delayed recovery or less complete success in results of operation.

The death of one of the great surgical leaders, Dr. George H. Monks, of Boston, which occurred early this year, led me to think of some observations he made on a visit to St. Mary's Hospital thirty years ago. I was operating on a fleshy patient with a tumor of the descending colon and a short mesentery. The operation was being carried on with considerable difficulty. Doctor Monks observed to me that inasmuch as the colon had developed on the left side of the abdomen, and the cæcum had travelled three-quarters of the way around the abdomen, enclosing the mesentery of the small intestine, all of its blood supply and innervation was contained in its inner leaf. If one looked at the lateral parietal peritoneum, he said, the juncture where the outer leaf united with the parietal peritoneum showed by a fine white line, and if this line were used as the point of division with the knife, the colon would swing out of the incision on to the abdominal wall without injury to any vital structure. I have often made use of this procedure in surgery of the large bowel. To further illustrate the point: one year ago a married woman, thirty-four years of age, had undergone an operation at her home, for the relief of pelvic abscess, with adhesions to the sigmoid. In the course of the operation several perforations of the sigmoid had occurred, and the surgeon had removed several inches of it. He then had found it impossible to close the gap between the rectosigmoid and the proximal end of the sigmoid by as much as four inches. Therefore he closed both ends of the bowel and made a permanent colonic stoma in the upper part of the descending colon. The patient came to the clinic in considerable mental distress. The surgeon who undertook the repair was able, by incising this white line of the descending colon, below the stoma, to mobilize the bowel sufficiently to reattach it to the rectosigmoid. The condition was completely relieved.

At the time of Doctor Monks' visit, he spoke of the advantage at times of knowing which was the "up" and which was the "down" of any loop of small intestine without making greater exposure than necessary, or effecting partial evisceration. Such knowledge was particularly valuable, he said, when the bowel was distended with gas, and when a small incision would suffice for anastomosis or drainage by a tube. The point was that the mesentery of the small intestine is folded together at its attachment over the spinal column like the blades of a fan, and if the intestine were lightly held by one hand, and the thumb and finger of the other hand slipped down on each side of the mesentery to its attachment, without it being necessary to rotate the finger or thumb before the base was reached, then the part that was up was proximal; on the other hand, if the mesentery turned, the thumb and finger also would have to turn, and the end that was down was proximal. To find this out requires only a second of time, and a short incision.

In anastomosis of the small intestine, a surgeon may be able to employ his favorite procedure; however, there are occasions when there is but little

choice. To know all methods is important, for any one of them may be best and safest in a given case.

Relief of obstruction of the upper part of the small intestine is attended by very high mortality, because operation is usually performed a day too late. A colon distended because of obstruction is most dangerous when seen late, and temporary cecostomy or colostomy must precede radical surgery, and must be performed with almost no manipulation of the colon or examination of the abdomen. The colon may be totally obstructed for some days, the small intestine for three days, and yet both relieved by insertion of a tube into the distended bowel; secondary operation may be performed later if possible.

End-to-side anastomosis between the ileum and colon furnishes an ideal opportunity for use of a Murphy button. This anastomosis may be made for relief of obstruction or for fistula, or in preparation for removal of the right half of the colon, at the same operation or at a later time. If side-to-side anastomosis is made, I have perforated the mesentery next to the distal part of the ileum, below the point of anastomosis, and have drawn adjacent tags of fat through the opening and around the bowel. This serves as a living ligature, and induces the content of the small intestine to pass through the anastomosis instead of part of it passing into the cæcum.

In removal of the right half of the colon in a single stage, I have found the danger to be tension from gas. If, in performing end-to-side anastomosis of ileum and colon, the closed distal end of the colon is brought into the wound of closure of peritoneum and abdominal wall, and is held there by the invaginating sutures which previously have been brought through the adjacent omentum, an opportunity is given to perforate the colon in the one case out of six in which such a procedure is required on the third night or the fourth morning. Without this preparation the procedure for relief would be delayed twenty-four hours to see if it was needed.

The stimulus to contraction of open granulation tissue that is exerted by colon bacilli is not generally appreciated. Fistulas of the small intestine rarely heal, but fistulas of the colon will continue to contract from the stimulation to formation of connective tissue exerted by colon bacilli until the large openings often close of themselves. This contraction continues as long as there is exposed granulation tissue, but where there is union of skin and mucous membrane of the colon, as is made in colostomy, there is no contraction. Murphy used to say: "I wish I could extract out of the colon bacilli that which does it."

I have watched surgeons use great care to keep the mesenteric attachments adjusted exactly to each other in making an end-to-end anastomosis of the intestine. This leaves two fat areas, without peritoneum, joined to each other. If the bowel is rotated a quarter of an inch, an area with perfect peritoneal protection is joined to an area that has no such protection, union is immediate, and peristalsis is not interfered with in any way.

In operating for gunshot wounds, after closure of perforations on the side of the bowel, additional protection can be given by rolling the bowel

against its own mesentery; nearby openings in the bowel, after their closure, can be sutured against each other and each can perforate into the other without symptoms or danger.

In dividing the small intestine for anastomosis it should not be cut at right angles, but obliquely, on a slant of a quarter to a half inch, with the greater length of bowel on the mesenteric side, that this enlarged outlet may have a better blood supply on the part opposite the mesentery than a right-angled cut could give. Also, with an oblique cut, what is taken up by the suturing is provided for by the enlarged perimeter of the bowel. An opening of any size larger than the normal diameter of the bowel can be secured by splitting the bowel and cutting off the tips of the flaps.

Suturing of the small bowel is not so serious a matter as suturing of the large bowel. The small bowel must be water-tight, but the large bowel must be both gas- and water-tight, and, depending considerably on the age of the patient, the length of time of obstruction, and the condition of the bowel with regard to bacteria beneath the peritoneum, the least bruise or pinch may mean peritonitis. Dark bowel, if dull in color, will not live, but if dark bowel has a sheen and is not touched in such a way as to abrade its peritoneum, it has a fair chance of recovering.

It often is necessary to provide a vent for gases and fluids in the immediate neighborhood of anastomosis. The old Witzel method of inserting a catheter makes very efficient drainage. Many years ago I reported a simple method of preventing the drained intestine from adhering to the fixed parietal peritoneum around the point of insertion of the tube. By this method the tube is drawn through the omentum and through a perforation of the abdominal wall, say an inch to one side of the main abdominal incision. There seldom will be any leakage if tubes are brought to the exterior in this way, and usually a special procedure to aid closure is not necessary. The omentum is one tissue in the body which is always prepared for emergencies by having extra leucocytes available; all other tissues must wait for inflammation to produce an increase of leucocytes. The omentum will immediately take care of considerable infection; it furnishes two to four added layers of peritoneal surface, according to the point at which it is perforated.

Drainage of the stomach, or drainage of the upper part of the jejunum, is sometimes necessary following gastroenterostomy. In cases of chronic distention of the stomach from pyloric obstruction, at times parietic retention occurs following a perfectly carried out gastroenterostomy. This may require repeated gastric lavage, or it may be necessary to insert a Rehfuß tube into the stomach for gastric or duodenal drainage. Such troubles may require much attention for three weeks before the stomach will contract normally and take up its peristaltic action; gastric lavage alone, or insertion of a small tube, combined with patience, may be quite effectual. At times it may be advisable to perform jejunostomy and to insert a No. 8 or 10 catheter into the jejunum about twelve inches from its origin; one end of the catheter is brought out through a stab wound. The catheter is passed up the jejunum,

and on through the gastroenteric stoma. Before the catheter is introduced, an added opening is made in it four inches from the lower end, and when the catheter is in place this opening lies within the jejunum. When the projecting end of the catheter is closed, the opening mentioned allows the fluid content of the stomach to pass on down the alimentary tract. However, when the projecting end of the catheter is open, gastric content can be secured from it, for examination, and food can be introduced through it. Without the opening in the catheter, a second tube inserted two or three inches lower, and turned downward, gives opportunity, when they are united externally by a glass tube, to watch and also to test the content of the intestine. Such a tube may be used also for feeding, and for administration of fluid. Glucose solution and above all plenty of saline solution are required in such cases and are easy to give.

Sometimes the surgeon, in performing posterior gastroenterostomy, insists on placing the structures within the loop of the middle colic artery, when that loop is too small to allow such a procedure with safety, and a dropped stomach closes off the circulation. Twenty-five per cent. of people have no anastomosis between the inferior and the superior mesenteric blood supply; this anomaly occurs in the region of the descending colon, or in that of the left side of the transverse colon. Any interference with the blood supply caused by injury of the middle colic arterial loop of such persons will lead to left mesenteric thrombosis. Such thrombosis was not uncommon twenty years ago following posterior gastroenterostomy, but now it is seen rarely. Colostomy involving the descending colon in the presence of this anomaly or when the mesentery is short may result in gangrene of the colon above the point of tension, and the circulation must be tested in such cases before the bowel is opened.

I like the Mikulicz operation for cancer of the left half of the colon. It is of advantage especially for cancer of the sigmoid, but when this operation cannot be used, resection of the sigmoid and again uniting the bowel over a large rubber tube passed through the rectum and out at the anus is a good procedure.

After resection of the colon it is of advantage to forestall tension exerted by gas retained in the lower bowel by dividing the sphincter with a cautery. Where division by knife would allow infection to enter, the cautery prevents infection, and scar tissue contracts at the end of six weeks, restoring good control. Primary colostomy often prevents distention in operations performed in two stages or in multiple stages. A vaccine prepared from colon bacilli and streptococci is of advantage in raising peritoneal resistance before operations on the large bowel in single stages.

It has been of great comfort to me to know when and where to employ these several procedures, of which I have developed but a few.

The higher the percentage of necropsies a surgeon is able to secure of those who die following operation, the lower will be his rate of mortality, because his knowledge will be increased by necropsy.

THE ACTION OF MORPHINE ON THE SMALL INTESTINE AND ITS CLINICAL APPLICATION IN THE TREATMENT OF PERITONITIS AND INTESTINAL OBSTRUCTION

By THOMAS G. ORR, M.D.

OF KANSAS CITY, KANSAS

MUCH time and energy have been expended in the study of the action of opium derivatives upon the gastro-intestinal tract. This study has established beyond doubt that morphine and other such alkaloids do have a definite effect upon the intestinal movements, although the exact mechanism of such effect may not be fully explained. Regardless of the exact mode of action of an opiate upon the muscle of the intestine the result of such action has been positively observed and with this information an estimate of its practical therapeutic value may with safety be made.

Renewed interest in the study of the action of opium derivatives upon the alimentary canal has recently been stimulated by Plant and Miller¹ and by Gruber and Robinson.² These writers have reviewed the subject thoroughly and have very convincingly established by their own researches that morphine has certain definite stimulating effect upon the smooth muscle of the bowel. Plant and Miller made their observations in unanæsthetized dogs with Thiry-Vella fistulas and in human beings with large thin-walled herniæ. They reported an increase in the general tone, an increase in the amplitude of rhythmic contractions and an increase in frequency and amplitude of peristaltic waves of the small bowel. They also noted an increase in the general tone of the colon musculature.³ Gruber and Robinson likewise observed an increase in tone of the ileum after giving morphine sulphate intravenously to dogs. In their experiments repeated injections of morphine intravenously led to a decrease in general tone of the intestine and in some instances increased force of the rhythmic contractions. Dvorak and his associates⁴ found an increase in intestinal tone and peristaltic activity in both animals and patients with and without bowel obstruction after giving moderate doses of morphine. Reid,⁵ working in Ivy's laboratory, made the significant observation that hypertonic sodium chloride solutions injected intravenously increased the propulsive power of the intestine while morphine did not, although the latter increased the tone and rhythmic activity.

The constipating effect of opium and its derivatives is apparently due chiefly to its spastic effect on the sphincters, and perhaps to a decrease in the upper intestinal and pancreatic secretions.^{6, 7} A delay in the progress of barium through the pylorus and ileocecal region has been satisfactorily demonstrated in both patients and animals after morphine administration.

It has long been believed by a majority of clinicians that opium and its alkaloids relax gastro-intestinal spasm and stop all peristalsis. With this in mind the drug has been liberally used to put the bowel at rest as a definite therapeutic measure in certain diseases involving the intestinal tract. The name of Alonzo Clark⁸ stands prominently in surgical literature as an advocate of large doses of opium in the treatment of peritonitis. From his

observations, beginning in 1840, he conceived the idea "that to establish the narcotic effects of opium within safe limits, and continue them by repeated administration of the drug, would cure uncomplicated peritonitis—that a kind of saturation of the system with opium would be inconsistent with the progress of the inflammation, and would subdue it." The dosage of opium and morphine used by Clark varied within wide limits. He began with small doses and increased them to produce a definite profound narcotic effect. His direction to one of his house surgeons when treating cases of puerperal infection was to "narcotize those women within an inch of their lives." He recites the case of a ten-year-old boy with peritonitis lasting forty days in which the sulphate of morphia was gradually increased until the patient was receiving a grain and a quarter every forty minutes. On the twelfth day of the disease, a woman was given 261 grains of opium. These were apparently extreme cases, but illustrate the disregard which he had for quantity of the drug when a definite narcotizing effect was sought. He says that "purgatives are entirely inadmissible. The bowels should be left entirely at rest until they recover their muscular tone; then they will expel first the gas, and then the fæces; or if, after the inflammation is subdued, they do not move of their own accord, injections are admissible. I have often left the bowels absolutely inactive for fourteen days without any recognizable consequence."

The popularity of Alonzo Clark's teaching was apparently somewhat overshadowed by the forceful declarations of Lawson Tait,⁹ in 1892. Tait made the statements that "peritonitis is not a lesion which fits into the germ theory of disease at all, and it is no use talking about treating peritonitis; you have not a chance as a rule; you must prevent it." He discontinued the use of opium by mouth absolutely after abdominal operations and only occasionally gave one dose of morphine by hypodermic. The basis of his treatment was through purgation for peritonitis, threatened peritonitis or "anything which seems to be likely to turn out peritonitis."

The opposing views of Alonzo Clark and Lawson Tait have both had ample support by surgeons through the years since 1840 with varying degrees of success. In 1908, Stockton,¹⁰ of Buffalo, emphasized the merits of morphine in the treatment of peritonitis and recited the case of a young girl eleven years of age to whom he gave the drug in doses of one-third to three grains at intervals of four to six hours. In the same journal immediately following his article Bovee,¹¹ of Washington, stated that he was not a believer in the Alonzo Clark treatment of peritonitis by opium splints and preferred to withhold opium entirely if possible. Crile and Lower¹² advocated deep morphinization in the treatment of acute appendicitis. It was their conception that morphine prevented exhaustion of the kinetic system.

The beneficial results claimed for the opium and morphine treatment of peritonitis have been based entirely upon false conceptions of the action of morphine upon the intestines. More accurate knowledge of the action of this drug on the muscle of the bowel leads us to a new explanation of its usefulness in the therapy of acute peritonitis and obstructive lesions of the

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intestines. Wilen and Dragstedt¹³ have very aptly remarked that the interpretation of its beneficial action in peritonitis must be on some other basis than that of abolishing intestinal activity and putting the intestine at rest.

Experimental Results.—In an effort to estimate the value of morphine and codeine in the treatment of peritonitis and intestinal obstruction we have repeated some of the experiments of Plant and Miller, using the Thiry-Vella fistula and in addition the Ivy-Mann fistula^{14, 15} in normal dogs and in dogs with obstructions of the jejunum.¹⁶ Morphine sulphate in doses comparable to therapeutic dosage in the human being definitely increased the bowel tone, the amplitude of the segmentation movements and initiated peristaltic waves. Large doses abolished the peristaltic action and somewhat decreased the tone but did not affect the rhythmic contractions. Very large doses increased the amplitude of the rhythmic segmentation movements. It was interesting to note that the jejunum did not lose its power to respond to morphine stimulation even in moribund animals. Kymographical tracings were made from both Thiry-Vella loops and obstructed portions of the bowel the day of obstruction and the day of death. As long as the animal was alive, an intestinal response to morphine was obtained.

The emptying time of the stomach and ileum was studied in dogs receiving barium before and after the administration of morphine by hypodermic injection. The stomach content was delayed two hours after giving morphine. Barium given through an ileostomy into the terminal ileum emptied in two hours without morphine. After giving morphine all the barium remained in the terminal ileum at the end of two hours.

Clinical observations confirmed the experimental findings that morphine definitely stimulates the activity of the small bowel. This was strikingly demonstrated in a large thin-walled umbilical hernia. The increase in activity was repeatedly noted after quarter-grain doses. In an adult woman with lower abdominal peritonitis, accidentally receiving an overdose of morphine which reduced her respirations to six, definite bowel sounds could distinctly be heard. The characteristic borborygmi of distended small intestine have been noticeably increased in several cases of acute peritonitis and intestinal obstruction. Direct observation has been made of a portion of protruding terminal ileum following permanent ileostomy. The increased activity of the visible portion of the gut was always noted after the average therapeutic dose of morphine by hypodermic injection.

Clinical Application of Experimental Findings.—One of the most dreaded features of the pathology of acute peritonitis and acute intestinal obstruction is the overdistention of the small bowel. Patients seldom die with these diseases if distention of the stomach or small intestine does not exist. Gatch and his co-workers¹⁷ have impressed upon us the great importance of bowel distention, giving adequate reasons why overdistention may be an important lethal factor in obstructive lesions. As the distention within the bowel increases, the circulation through its wall decreases. Transperitoneal absorption of the toxic material found in the bowel in intestinal obstruction may

occur through a non-necrotic bowel wall rendered anæmic by distention. The contents of both obstructed and normal bowel are equally toxic.¹⁸ Toxic substances found within the bowel are not absorbed unless there has been some damage to the bowel wall. A gut that retains its tone absorbs gases readily. A gut that retains its tone absorbs things it should absorb and does not absorb things it should not absorb. The rate of blood flow through the muscle probably increases its activity. The presence of peritoneal exudates on the bowel surfaces does not alone decrease peristalsis.¹⁹ Distention is the essential factor in reducing bowel activity. In diseases, such as peritonitis and intestinal obstruction, which have as part of their pathology excessive bowel distention, any successful effort to combat such distention will prolong life. Any medication designed to relax or splint the bowel to prevent intestinal movement and the spread of infection is, in the present state of our knowledge concerning distention, founded upon erroneous premises.

Since morphine (and codeine) definitely stimulate the bowel tone and rhythmic contractions, its use is logical in peritonitis, paralytic ileus and bowel obstruction to prevent overdistention. Clinical experience has conclusively proven that there is no foundation for the supposition that such stimulated bowel activity spreads infection. If violent peristalsis be a danger, it is obviated in the use of large doses of morphine by the fact that such doses reduce peristaltic waves of the rush type, but still maintain an increase in tone and rhythmic movements. In addition to its action on the bowel, morphine relieves pain, restlessness, apprehension and the discomfort of thirst, thereby conserving the patient's strength and endurance.

The duration of morphine action on the bowel is at least six hours. Morphine given every four hours will, therefore, exert a continuous stimulating action. It is recommended in doses sufficiently large to keep the patient continuously drowsy and quiet during the height of the disease. The older clinicians who have used opium and its derivatives in the treatment of peritonitis emphasize the futility of timidity in its use. Its value is based upon a dosage sufficient to produce definite and continuous narcosis. Danger signals are respirations below twelve per minute or the appearance of cyanosis.

In addition to the use of morphine, special attention should be given to the maintenance of water, chemical and metabolic balance in the treatment of any intra-abdominal condition involving distention of the small bowel. It is well known that hypertonic solutions of sodium chloride given intravenously will stimulate bowel tone and peristalsis. Since this is true, it is reasonable to believe that a normal sodium chloride content of the body tissues will aid in maintaining proper muscle tone of the intestine. In the treatment of acute peritonitis secondary to intestinal-tract infections nothing is given by rectum during the acute stage. Water by mouth is given only to be removed at once by an indwelling siphonage or suction stomach or duodenal tube. When the infection is overcome the patient will usually begin to pass gas by bowel. At this time enemata may be given to aid in emptying the colon.

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As an aid in treatment and prognosis, frequent auscultation of the abdomen is recommended during the morphine treatment of abdominal distention. The presence of gas and liquid in a distended bowel gives a characteristic tinkling sound during bowel activity which is totally different from the more muffled sounds of the normally functioning gut.

Careful attention has been given to the consideration of any harmful effects of opium derivatives in the treatment of very ill patients with acute peritonitis and intestinal obstruction. The possibility of narcotic addiction is, of course, recognized. This should be a guarded but not a deterrent factor in the treatment. Slowing of respirations has not been harmful as far as can be determined by the observation of clinical cases. If morphine has any deleterious effect upon gland secretion, circulatory activity or general metabolism it is not evident clinically. Morphine given in large doses in experimental intestinal obstruction does not shorten the life of animals. This is also true of high jejunostomies which result in death in from two to six days.²⁰

CONCLUSIONS.—(1) Morphine and related opium derivatives when given hypodermically stimulate the tone, rhythmic contraction, and in some degree peristaltic waves of the small intestine for a period of at least six hours.

(2) To prevent overdilatation of the small intestine morphine is indicated in the treatment of acute peritonitis, intestinal obstruction and so-called paralytic ileus.

(3) The maximum clinical benefits can be obtained only by giving morphine in sufficient dosage to produce continuous narcosis.

(4) By maintaining the tone and rhythmic contractions of the small intestine with morphine, distention is controlled and disturbance of the bowel circulation is prevented during the course of the disease until the cause of the bowel distention is overcome by the natural defensive powers of the patient.

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DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Va.) said he had seen some of Doctor Orr's work a few weeks ago. He saw the original tracings. The application of his experimental work is quite wide, it seemed to him, and it rather reverses one's preconceived ideas—at least his ideas—about the effect of morphine on the gastro-intestinal tract.

Morphine, if it tends to keep up the tone of the intestine, as he has seemed to show quite conclusively, both by experimental work and clinically, is not contraindicated in peritonitis as it used to be thought, but is positively indicated. It adds not only to the patient's comfort but to his physiological resistance.

DR. ELLSWORTH ELIOT (New York City) reported the case in an adult of a spreading peritonitis in 1877, in which, after consultation with Dr. Alonzo Clark, large doses of opium were administered without apparent effect on the course or duration of the infection. The patient died on the sixth day. A perforated gangrenous appendix with exterior abscess was found on autopsy. At that time no operations were done for this condition.

DR. THOMAS G. ORR said that in Alonzo Clark's articles he apparently had the notion that morphine had some specific effect upon peritonitis. Doctor Orr did not believe this to be correct. Morphine simply helps to prevent the abdominal distention until the patient can overcome his infection. Up to date we have no specific treatment for these conditions and we can only hope to support the patient until he can overcome them by his own resistance.

BENIGN ENCAPSULATED TUMORS IN THE LATERAL VENTRICLES OF THE BRAIN: DIAGNOSIS AND TREATMENT

By WALTER E. DANDY, M.D.

OF BALTIMORE, MD.

FROM THE JOHNS HOPKINS UNIVERSITY

IN THIS communication thirteen benign encapsulated tumors in the lateral ventricles of the brain are reported. There are no signs or symptoms by which enucleable tumors can be differentiated from the invasive gliomata or other malignant types of tumor which protrude into or obliterate the ventricles.

From the literature twenty-five additional cases have been found; all of these have been post-mortem findings. None has been diagnosed during life or removed at operation. From an analysis of the signs and symptoms of the tumors in the literature, together with those in my series there is no clinical syndrome by which these tumors can be localized with sufficient accuracy to be found at operation. It is true that some of them have hemiplegia, but this by no means permits accurate localization of the growth. All of these tumors can, however, be localized with absolute precision by means of ventriculography. (Figs. 1 and 2.) When used correctly there is no danger whatever in this procedure. In our series all have been found at operation. Ten have been removed and the patients are well; three died from the effects of the operation. In the last nine cases there has been but one death. The longest survival period has been fourteen years. This chanced to be the first tumor that was localized by ventriculography.

Primary benign ventricular tumors occur in about 0.75 per cent. of all brain tumors. They occur in any part of the lateral ventricles. (Fig. 3.) The youngest patient was twelve, the oldest forty; they, therefore, occur during the period of youth. The duration of symptoms varied from five months to nine years, the average being one to two years. The only constant symptom is headache. There may be nausea, vomiting, diplopia, dizziness and papilledema, all of which are purely indications of intracranial pressure. A positive Romberg or a history of staggering gait may mislead the operator into a diagnosis of a cerebellar tumor. Some degree of sensory or motor unilateral paralysis was present in about one-half of the cases.

Character of the Tumors.—The tumors are of various types, most of them ependymal gliomata, but they are entirely different from the gliomata that arise in the cerebral tissue. They are well encapsulated, except at the small point of origin in the ependyma, and this is easily removable with the tumor. In none has there been recurrence. There have been two pure fibromata (Fig. 4); these were the largest in the series, weighing 95 and 124 grams, respectively, and both grew out of the glomus of the choroid

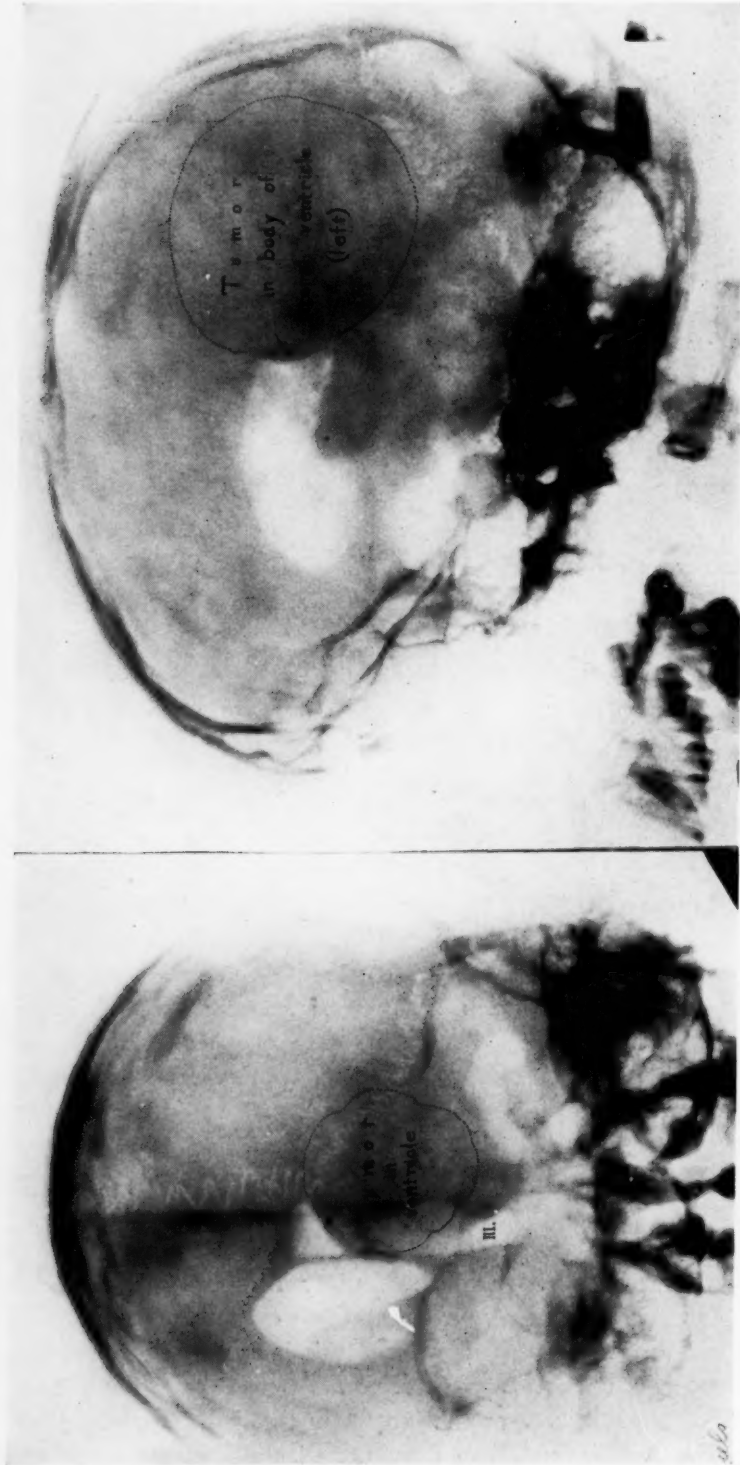


FIG. 1.

FIG. 1.—Anteroposterior ventriculogram showing defect with a sharp oblique border in the right lateral ventricle. In addition there is a dislocation of the ventricular system to the left and obliquity of the third ventricle.

FIG. 2.

FIG. 2.—Lateral ventriculogram showing sharp termination of the air shadow in the body of the left lateral ventricle.

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FIG. 3.—Tumor in right lateral ventricle causing preceding ventriculographic changes.

plexus. One tumor was an adenoma of the choroid plexus, and another was a venous aneurism in the wall of the body of the ventricle. (Figs. 5 and 6.) This was completely extirpated following a second intracranial hæmorrhage with hemiplegia.

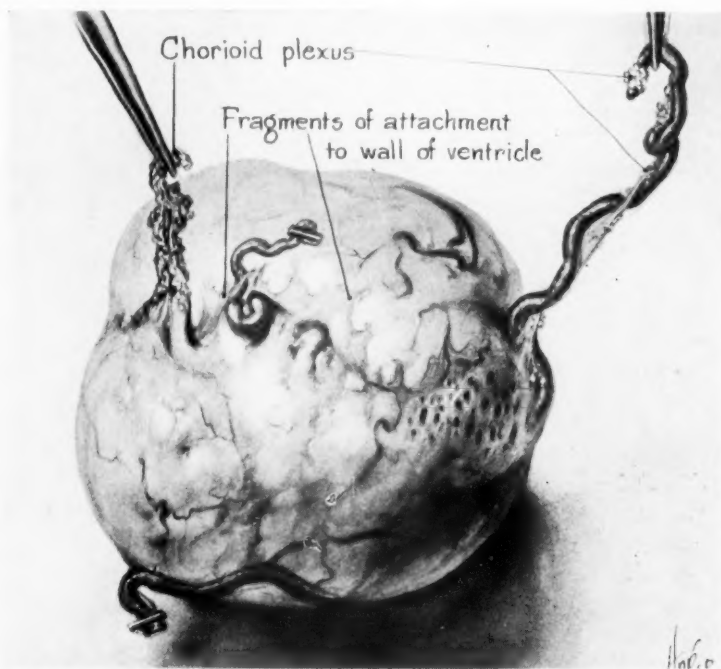


FIG. 4.—Tumor causing above ventriculographic changes. It is a pure fibroma arising from the glomus of the choroid plexus.

Ventriculographic Findings.—These are of various types, depending upon the size and position of the tumor; always they are pathognomonic. A sharp line indicating the termination of the air shadow accurately marks one

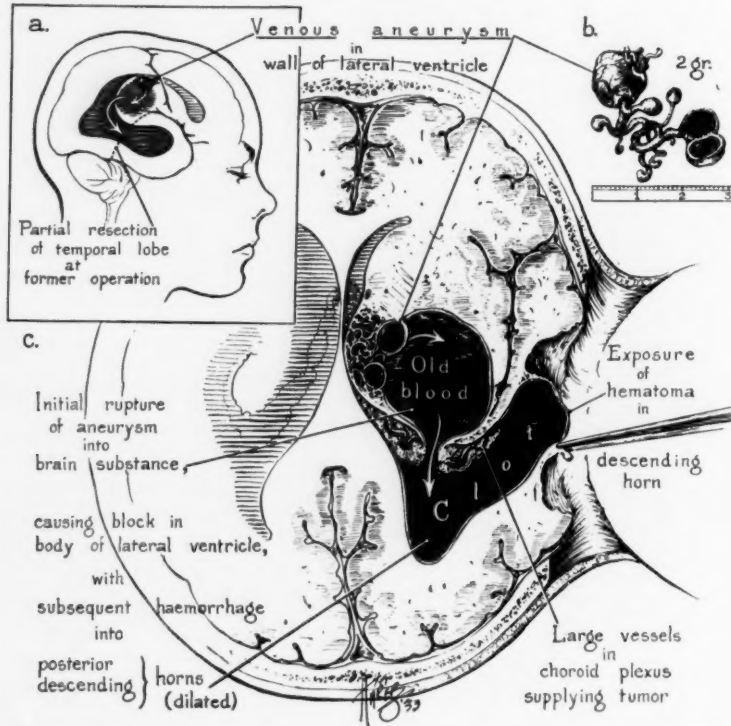


FIG. 5.—Venous aneurysm incorporated in the right ventricular wall. It had bled on two occasions producing hemiplegia. After removal of the hematoma the aneurysm was disclosed and removed.

pole of the tumor. A sharp straight or curved line suggests a benign type of tumor, but one cannot always be certain from the ventriculographical evidence alone that the tumor is of the encapsulated type. Always, there is

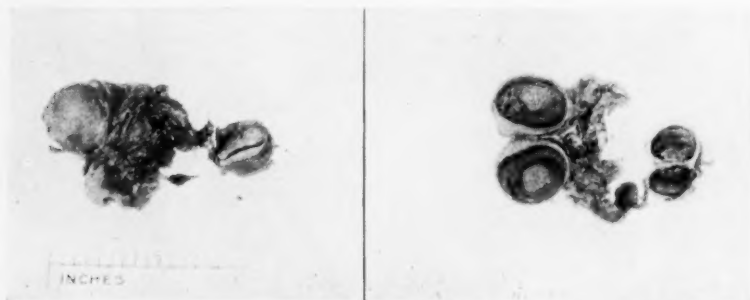


FIG. 6.—Photograph of aneurysm. There were several discrete venous pouches, as shown in the preceding Fig. 5.

hydrocephalus distal to the tumor and caused by the obstruction of the ventricular system. A tumor may also block the ventricular system at a

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distance from the tumor, *i.e.*, by lateral compression of the aqueduct of Sylvius or the third ventricle.

Treatment.—A cure, of course, can be accomplished only by the removal of the tumor, and the earlier the diagnosis the better the patient's chances. It is always necessary to remove an area of cortex (Fig. 7) either directly overlying the tumor, if that part of the brain is silent, or if the tumor lies in the motor or another important area of the brain, the cortical defect must

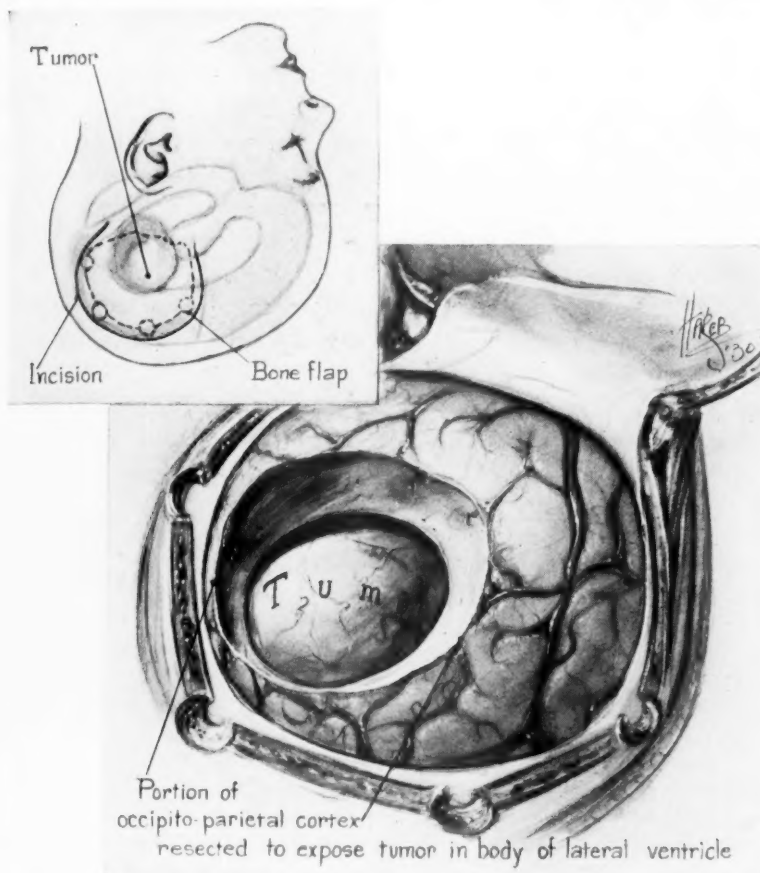


FIG. 7.—Operative approach to tumor; an area of cerebral cortex is resected in order to permit access to the growth.

be made anterior or posterior to the tumor and enucleation may be made through this defect.

DISCUSSION.—DR. GEORGE J. HEUER (New York City) remarked upon the enormous contribution which ventriculography had made to the diagnosis of certain brain tumors. He recalled in his own experience how impossible it was to make a diagnosis of an intraventricular tumor and that these cases were operated upon sometimes when the tumor was not found. They eventually came to autopsy and at that time the tumor was discovered. It is an illustration, he thought, of the advances that are being made in neurosurgery.

ORIGIN AND COURSE OF INFECTION IN SUBPHRENIC ABSCESS

BY PHILEMON E. TRUESDALE, M.D.

OF FALL RIVER, MASS.

THERE has been considerable discussion as to the avenue by which infection reaches the diaphragm. Although there are many sources from which infection may extend to the diaphragm to produce abscess, such as appendicitis, perforated peptic ulcer, cholecystitis, ruptured diverticulitis, furunculosis, and other septic foci in the body, the most common site of origin is either an appendiceal abscess or a perforated peptic ulcer. In 890 observations, Piquand¹ found 251 cases of gastric origin, 191 appendiceal, 131 hepatic, fifty intestinal, forty splenic, twenty-seven pancreatic, twenty-six renal, seventeen genital, and thirty-two originating in the thorax. These figures agree with statistics compiled by Barnard,² Lockwood,³ and Fifield and Love,⁴ who name peptic ulcer, biliary disease and appendicitis as the principal sources of infection.

From a study of our own twelve cases of subphrenic abscess and from opinions expressed by contemporary authors, we are led to believe that the most common channel of infection is by way of the lymphatics. In studying their function as conveyors of infection it is difficult to determine the exact anatomical relationships involved. To secure a clear picture of lymphatic distribution it is essential to review the methods by which the lymphatic system was outlined by three investigators during the previous century.

First was the method of Mascagni,⁵ which was published near the close of the Eighteenth century. It consisted of the injection of a colored solution of gelatin into the arteries. The solution after filling the blood-vessels passed through their walls, permeated the surrounding tissues, and was taken up by the lymphatics. Dilated by this liquid, which soon coagulated, the lymphatic vessels were made to stand out quite clearly. Then they were injected with mercury and traced throughout the course of their small branches. This method was incomplete, however, because it did not show the lymphatic trunks nor the entire network of capillaries. Thus at the end of the Eighteenth century we knew how the lymphatics united in their course and how they terminated, but not their origin. Mascagni left this great problem for his successors to solve.

The second method of showing the lymphatics appeared in 1830. It was introduced by Fohmann and Panizza.⁶ After injecting mercury under the skin, mucous membrane, or serosa, they dissected up these layers and found the anastomosis of the first radicles of the lymphatic system. But this brilliant network did not include the lymphatic trunks. Viewed with the naked eye they appeared excellent, but under the microscope they lost all importance because they seemed to indicate that lymphatic trunks did not exist.

The German method was applied to the absorbent epithelium of the vessels. By the use of silver nitrate, von Recklinghausen,⁷ in 1865, outlined this layer of cells and made it possible to examine the vessels under the microscope. This method offered great hopes, particularly in demonstrating the star-shaped cells indicating the origin of the lymphatic capillaries. But this silver stain often gave a result that was variable and a picture

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difficult to interpret. It possessed distinct advantages and was used about twelve years, but it was still an intermediate step.

Sappey's⁸ researches in 1874 differed entirely from those which had preceded. In order to bring the vessels into plain view, he did not direct his attention to the wall of the vessels but to their contents. He used the lymph itself as a means of investigation. He believed that if he could color the contained lymph, it would offer the best agent for determining the source from which it came. After lengthy and laborious study, he found a suitable color which imparted a dark tint and appeared almost black. Presently the flow of lymph through a network of transparent threads produced a deep tint in separating perfectly on the background of the preparation. Thus to the observer the conditions presented were similar to those of the capillaries when naturally or artificially injected. In this manner Sappey obtained the greatest degree of enlargement of the vessels and revealed the lymphatic trunks.



FIG. 1.

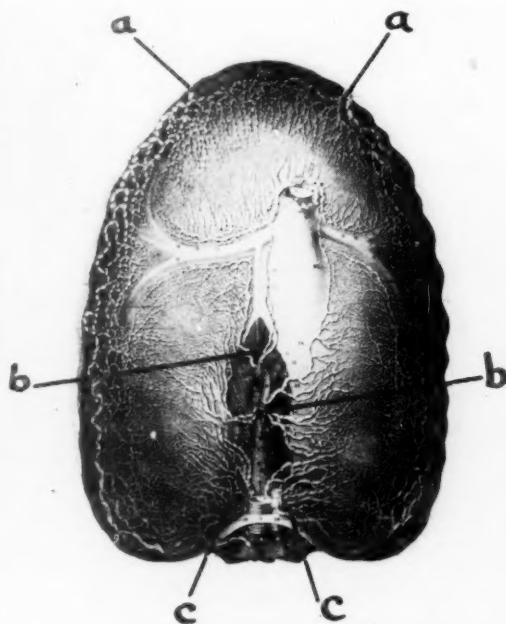


FIG. 2.

Following these collective researches, MacCallum,⁹ of Johns Hopkins, in 1903, may be considered to have contributed more than any of his predecessors to our knowledge of the complicated process by which granular materials are absorbed by the diaphragm through the peritoneum under normal and pathological conditions. He chose the diaphragm as the most important absorbing area of the peritoneum and studied in detail the anatomy of the tissues which separate the lumen of the lymphatic channels from the cavity of the peritoneum. On the pleural surface of the diaphragm the lymphatics anastomose abundantly and form a network over the whole surface. On the peritoneal side the lymphatics are arranged differently. In their arching course they lie in spaces between the connective-tissue fibres and are separated from the peritoneal cavity by an extraordinarily thin layer of tissue. These thin areas form the most favorable site for the entrance of materials from the peritoneum. These sac-like channels appear as small, diamond-shaped clear areas and are plainly seen in the accompanying illustration of the oesophagus. (Fig. 1.) When granular material is injected into the peritoneal cavity,

we find that these blind sacs or *lacunæ* in the diaphragm become injected with the granular substance, and from them we can trace the material into the anastomosing trunks of the pleural network, then into the efferent trunks, and on into the mediastinal lymph-glands.

MacCallum studied this tissue further by employing thin paraffin sections fixed in Zenker's fluid. The lymphatics were injected with an 0.5 per cent. solution of silver nitrate followed by agar which when cooled kept the channels widely distended. In this way the smoothly stretched lining could be studied. It was discovered that the endothelial lining of the lymphatics was complete with no perforations, and that the peritoneal

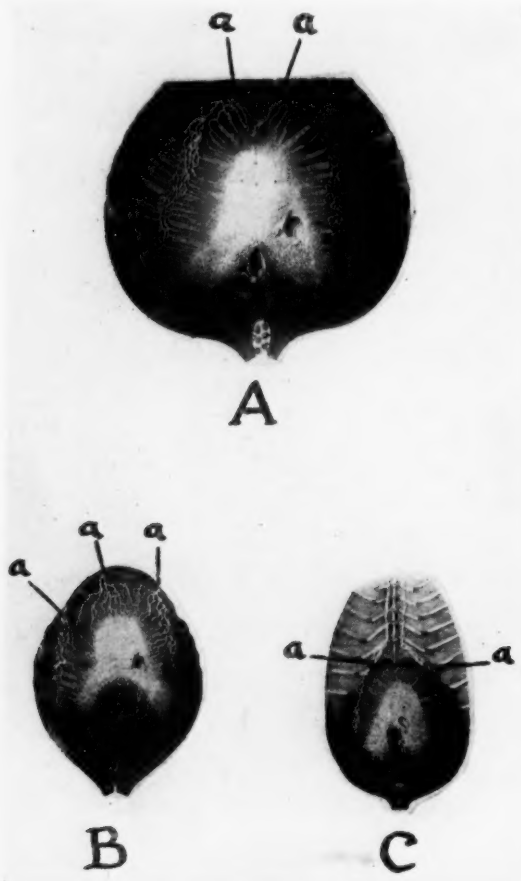


FIG. 3.

epithelium like the lymphatic endothelium was a complete membrane. The nature of the tissue between the peritoneal epithelium and the endothelium of the lymphatics was next studied. This basement membrane was demonstrated by Bizzozero,¹⁰ Vincenzi,¹¹ and Muscatello,¹² who macerated the tissue in Müller's fluid and alcohol and found that it could then be readily torn away in small strips. MacCallum found no communication between this basement membrane and the lymphatic *lacunæ*. These *lacunæ* were the absorbing terminals of the diaphragmatic lymphatics, had a complete lining endothelium, and were separated from the peritoneal cavity by loosely woven connective tissue and the peritoneal epithelium.

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MacCallum was forced to conclude that absorption of granular material was brought about by phagocytosis. He demonstrated this by injecting a suspension of carmine into the peritoneum of a rabbit. After a few hours, examination of the diaphragm showed the *lacunæ* sprinkled over with leucocytes which swarmed over the surface of the *lacunæ* and could be seen in large numbers making their way with the load of pigment through the roof of the *lacunæ*. Finally, the endothelial cells in the lymphatics became swollen with pigment.

CHART

ANALYSIS OF CASES		
Total Number Cases.....12		
I Sex	(a) Males.....8	(b) Females.....4
II Age	(a) Oldest.....72	(b) Youngest.....20 (c) Average.....44.5
III Symptoms	(a) Septic temperature.....	12
	(b) Definite leucocytosis.....	11
	(c) Local pain and tenderness.....	12
	(d) Evidence of fluid in chest.....	3
	(e) Referred pain to shoulder.....	3
	(f) Fecal expectoration.....	4
IV Cause	A. Following initial operation, for—.....	8
	(a) Acute suppurative appendicitis.....	4
	(b) Perforated duodenal ulcer.....	2
	(c) Acute cholecystitis.....	1
	(d) Carcinoma of oesophagus.....	1
	B. Abscess present on entry; origin undetermined.....	4
V Type of Drainage	(a) Thoracic.....	5
	(b) Abdominal.....	5
	(c) Abscess undrained.....	2
VI Result	(a) Died.....	9
	(b) Recovered.....	3
VII Operative mortality.....		70%
Total mortality.....		75%

Although MacCallum observed that individual cells could be separated by respiratory movements and fine granules forced between them, he found no support for the statement that there exists open communication between the peritoneum and the lymphatics and proved that the peritoneum is not a part of the lymphatic system. Each of these structures is lined with cells which retain their specificity throughout and nowhere merge into one another.

These investigations by MacCallum have not been disproved so far as we know.

The diaphragm of the horse, as injected by Sappey, owing to its enormous development, provides a good illustration of the origin of the lymphatic network covering the muscle fibers and accompanying them to the lymphatic trunks into which they drain. (See Fig. 2.) These comprise two anterior groups, *a a*, five trunks which lie centrally and give off branches that com-

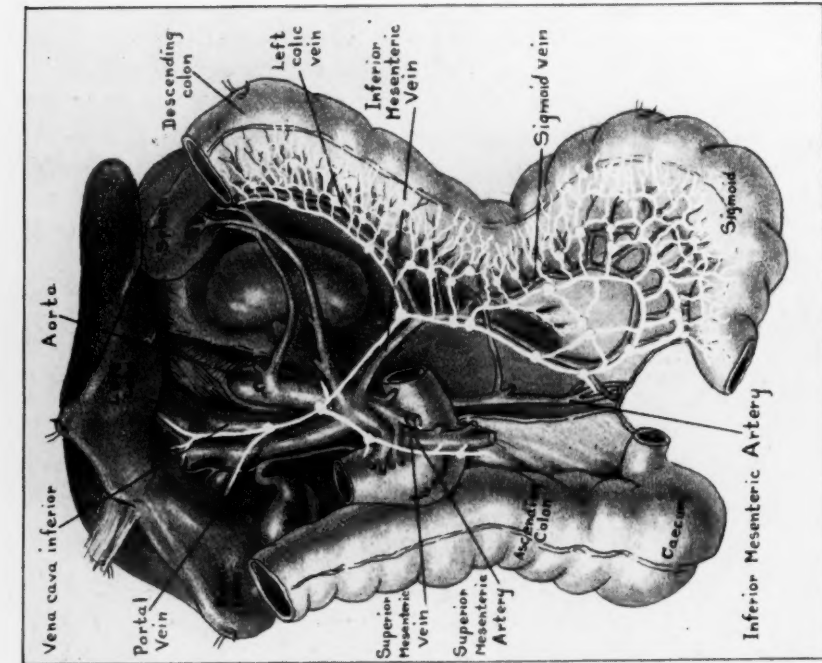


FIG. 5.

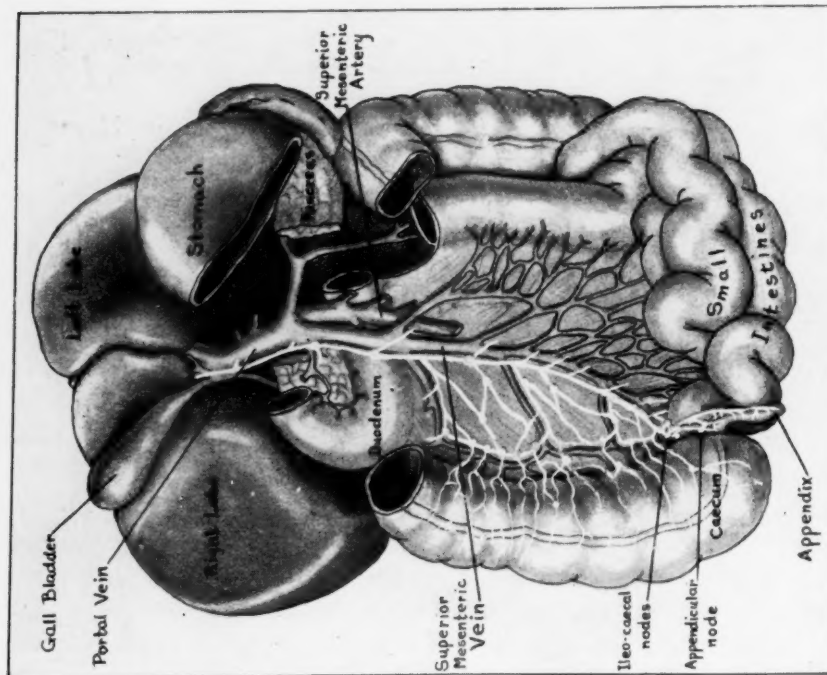


FIG. 4.

SUBPHRENIC ABSCESS

municate with glands located around the vena cava, *b b*, and five or six aortic trunks which lie posteriorly on either side, *c c*.

The next figure (Fig. 3) illustrates the lymphatic system in the diaphragm of a man, *A*, a dog, *B*, and a rabbit, *C*. In the rabbit the lymphatic system is as highly developed as in the dog. In both the arrangement is similar even in the anterior portions. In man, however, the two anterior groups *a a*, continue in closer relation with the mammary veins. In addition, one or two independent vessels are found between the two groups of main trunks which empty into the same vessels. In observing the myriads

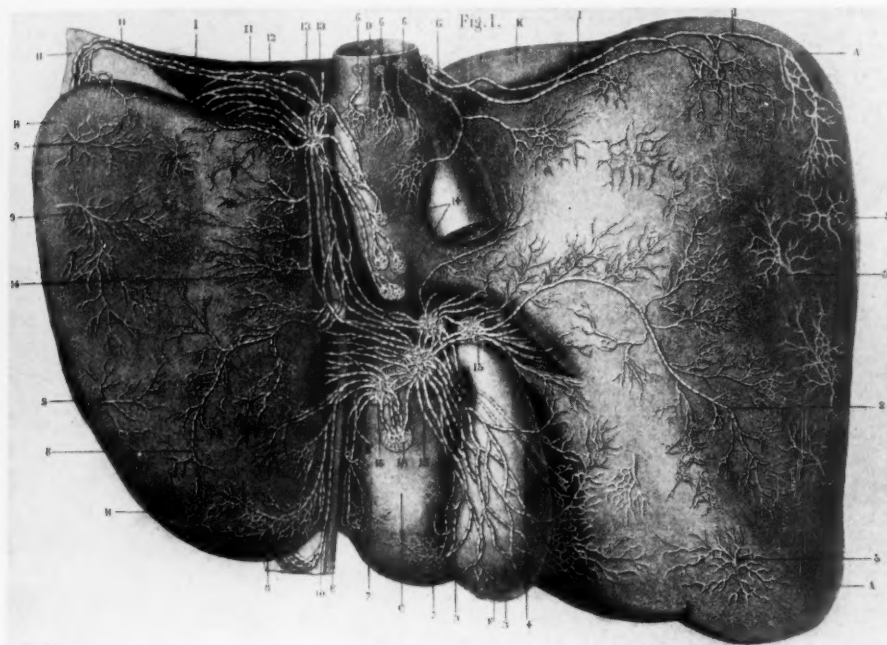


FIG. 6.

of small vessels contiguous and superimposed, one is surprised to find so many vessels in so thin a membrane.

The chart on page 849 contains a list of twelve cases of subphrenic abscess recorded at the Truesdale Hospital. In seven of the twelve cases the focus of infection was within the peritoneal cavity, in one case within the thorax, and in four undetermined, though in each the history was suggestive of an intestinal lesion. Four of the intraperitoneal cases followed operation for appendiceal abscess.

Since the majority of these cases developed as a sequela of appendicitis, we have studied the lymphatics in their course from the appendix to their distribution in the region about the diaphragm. The bacillus-laden lymph passes from the appendiceal abscess to the appendicular nodes which communicate with the ileocecal nodes. The stream then empties into the

lymphatic trunk following the superior mesenteric vein (Fig. 4) which in turn empties into the portal vein.

Likewise a focus of infection at any point in the descending colon would gain access to the lymph channels accompanying the inferior mesenteric vein (Fig. 5), which finds its way into the superior mesenteric vein before emptying into the portal vein. Thus the lymphatics draining the entire colon



FIG. 7. (Sappey)

reach the liver in juxtaposition with the mesenteric veins. This course of the lymphatics offers an explanation for the frequency of extension of malignant disease from the colon to the liver.

When the lymphatic vessels reach the liver they pursue a most intricate course. Their distribution is seen in detail in the next two illustrations.

On the inferior surface of the liver (Fig. 6) there are six principal trunks. Those which arise mainly from the right lobe of the liver (A)

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terminate in nodes surrounding the vena cava (1, 1, 6, 6, 6). Trunks 2, 3, 4, and 7 empty into nodes 15 resting on the neck of the gall-bladder. Deeper branches 5, 9, disappear in the liver to follow branches of the portal vein. Trunk 8 is the principal trunk of the left lobe (*B*). Trunks 10, 11, 12, and 13 come from the superior surface of the liver and terminate in nodes in the posterior part of the longitudinal fissure. Still other lymphatic trunks connect with the terminal part of the œsophagus, 14.

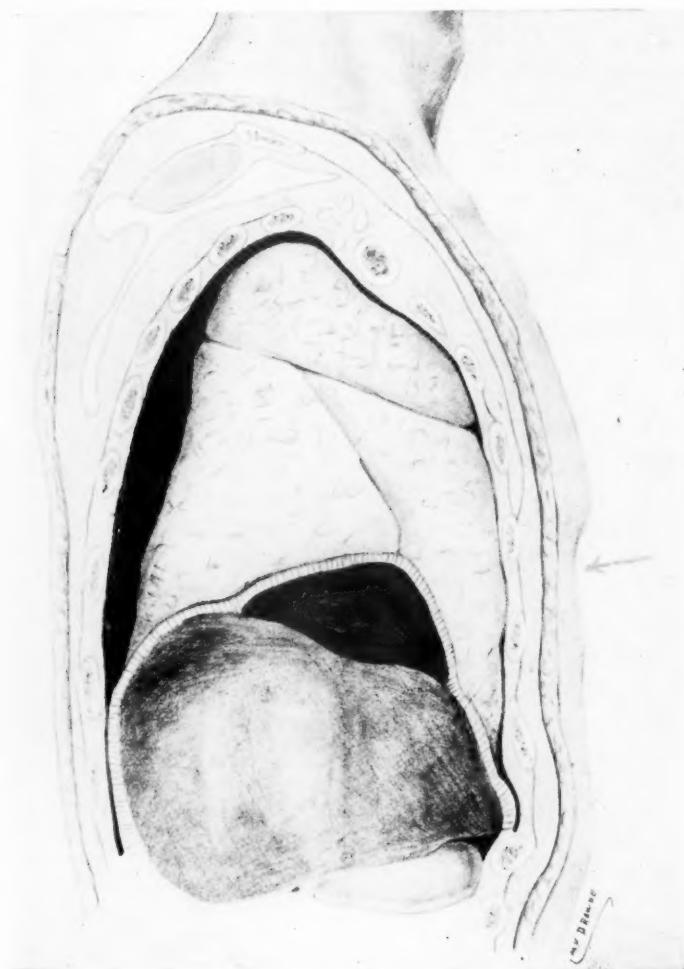


FIG. 8.

A more diffuse distribution of the lymphatics is noted on the superior surface of the liver. (Fig. 7.) The collecting stems are more conspicuous on the right lobe (*A*) than on the left (*B*). They pass forward and downward, 1, 2, as they curve around the anterior border of the liver and join stems from the gall-bladder, which pass into the hepatic nodes in the transverse fissure. In the anterior view (*A*, *B*, *C* in Fig. 7) the dense net-

work of lymphatic vessels is seen along the line of attachment of the falciform ligament. In Fig. B, side view, some lymphatic trunks are seen passing backward along the vena cava and through the diaphragm; others pass between the layers of the falciform ligament toward the under surface of the diaphragm. Figure C shows a cross-section through the liver. The lymphatic vessels are seen accompanying branches of the portal vein.

The lymphatic vessels which pass through the diaphragm finally terminate in the lower nodes of the inferior deep cervical group. Thus a direct route is provided for the metastasis of the supraclavicular nodes frequently induced by abdominal carcinomata; and since these stems also communicate with the lymphatics of the pleural surface of the diaphragm, which are closely associated with the thoracic vessels, opportunity is afforded for the development of pleuritis as a result of a subdiaphragmatic abscess.

After coursing through the liver the lymphatic vessels continue their route and finally reach the diaphragm with their infected lymph. Localizing above the liver, the infection develops into an abscess. Fig. 8 shows a subphrenic abscess with the superimposed right lung adherent to it. By blunt dissection the lung was separated from the diaphragm, revealing the site of rupture of the abscess where it communicated with the lung, a frequent channel of evacuation. The lung was peeled back to make the abscess accessible for drainage.

Summary.—The lymphatics are the common carriers of infection from the peritoneal cavity to the liver and diaphragm.

The diaphragm is richly supplied with lymphatics and on its peritoneal aspect is found an elaborate network of lymph-vessels which promotes rapid absorption.

The channels through which infection reaches the liver and diaphragm from the ileocecal region and the descending colon are quite clearly demonstrable.

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- ¹¹ Vincenzi: *Ibid.*
- ¹² Muscatello: *Ibid.*

VESTIGIAL MASTITIS

A HITHERTO UNRECOGNIZED SYNDROME

By ALEXIS V. MOSCHCOWITZ, M.D.

OF NEW YORK, N. Y.

IN ORDER to obviate all misconception, it is necessary to state at the outset that the lesion I am about to describe has nothing whatever to do with the somewhat hackneyed subject of supernumerary or aberrant breasts, hyperthelie, *etc.* The only relation between vestigial mastitis and the latter conditions is that both originate from a common embryonal anlage.

My theme will perhaps be easier to follow if I first submit short abstracts from the clinical histories of my cases.

CASE I.—Mrs. M. M., thirty-nine years of age, was referred to me by Dr. Eli Moschcowitz April 29, 1930, because of a tumor in the left breast which had existed without any appreciable change for a number of months. The tumor, about the size of a hazel-nut, presented the characteristics of an innocent fibro-adenoma and I did not hesitate to express myself in this manner and to reassure the patient. The tumor was located in the mamillary line, close to the inferior periphery of the breast. When my examination was completed, the patient casually called my attention to a peculiar, very shallow and very narrow groove which she had noticed during the past few months, and which extended, roughly speaking, from the upper margin of the breast in a rather graceful curve towards the corresponding axilla. This groove was about six inches long and was slightly tender on pressure. Never having encountered a groove of a similar nature, I continued my examination with particular care. Much to my surprise, I now discovered upon the abdomen not a groove like the one just described, but a cord, which began at the lower border of the breast, approximately, at the location of the previously described fibro-adenoma and which coursed in the general direction of the symphysis pubis. As far as it was traceable, this line was about eight inches long and gradually faded away. (Fig. 1.) It felt rather wiry and not unlike an adult vas deferens, but perhaps a trifle thinner. I particularly want to mention that this cord was not intracutaneous but distinctly subcutaneous, apparently within the fatty layer of the anterior abdominal wall. It was somewhat tender to pressure. In the presence of these additional findings, a justifiable doubt arose in my mind as to the correctness of my preliminary diagnosis of fibro-adenoma, and it occurred to me that the abdominal cord might be an aberrant lymphatic vessel containing a carcinomatous deposit, secondary to a possibly malignant tumor of the breast. This

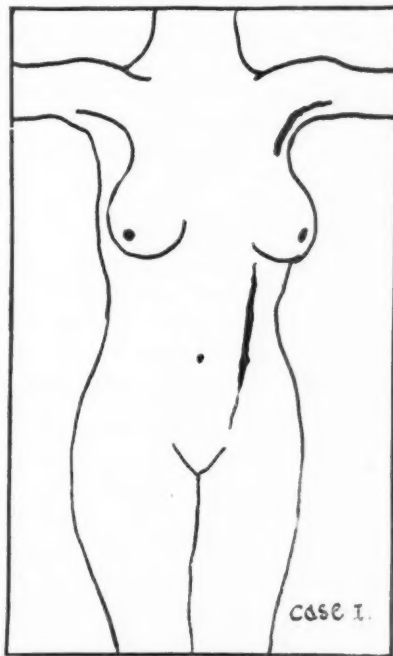


FIG. 1.—(Case I.) Note the presence of a supramammary cord and an infmammary cord on left side.

appeared to me rather more than plausible because of the peculiar location of the intramammary tumor, namely, close to the inferior margin of the breast. I explained my fear to the patient and urged exploration of the tumor. I also suggested the advisability of excising a small bit of the abdominal cord for microscopical examination.

Operation, May 6, 1930. The breast tumor was excised and was pronounced to be a fibro-adenoma. At the time of the operation, the cord in the anterior abdominal wall could no longer be recognized as a definite cord. An excised portion resembled somewhat firm infiltrated fat. The specimen excised from the abdominal wall which was at a considerable depth below the cutis was examined by Dr. Paul Klemperer,* Pathologist to Mount Sinai Hospital, and described in the following words:

"Section 4052, No. 2 (Figs. 2 and 3) shows several fragments of fat tissue, one of which includes tubular structures cut in longitudinal and cross-section. These tubular structures are lying within a connective-tissue matrix and are occasionally surrounded by a considerable number of lymphocytes intermingled with sporadic polymorphonuclear leucocytes and rare plasma-cells. These tubular structures vary in width, the widest contains some pink-staining amorphous material. The epithelial lining of this particular duct consists of flattened cells with cylindrical nuclei. Within the same connective-tissue stratum, there are similar ductlets which have a capillary lumen and are lined by columnar cells with rather pale nuclei. In one of the adjacent connective-tissue areas, there are numerous other cross-sections of ducts which are lined by columnar epithelium. These epithelial structures closely resemble the smaller ducts found in atrophic mammary tissue. There are no actual lobules present. The cellular infiltration of the stroma suggests a mild inflammatory process."

I see the patient at frequent intervals. Even a meticulous examination and palpation of both the supramammary and inframammary regions fail to reveal the slightest abnormality, nor does the patient complain in any manner. In parenthesis, I wish to mention at this point that I have noted similarly a complete disappearance of the definitely palpated cord in several other instances. I account for this phenomenon by assuming that the cord is palpable only when, for some hitherto unexplained reason, it is either inflamed or otherwise changed pathologically, as is evidenced by the specimen above described, and that upon the cessation of the inflammation it eludes detection, even though *de facto* it is still present. I wish to call particular attention to the fact that in the specimen obtained from this patient there is still in evidence a marked round-cell infiltration, a finding indicative of an inflammatory process. This inflammatory process, to my mind, also accounts for the pain of which all of these patients complain and which is the particular symptom which prompts them to seek medical advice.

CASE II.—Mrs. K. B., thirty-six years of age, was referred to me October 5, 1930, complaining of pain in the left half of the abdomen, without any more definite localization. Examination carried out punctiliously failed to reveal anything of a pathological nature within the abdomen. I was about to abandon all further efforts in quest of a diagnosis and seriously entertained the question of malingering. In order to exclude this eventuality I examined the patient, as I am accustomed to do for obvious reasons, while I directed her to contract her abdominal muscles. In executing this manoeuvre, my palpating fingers suddenly felt a cord which was located just about in front of the outer edge of the left rectus abdominis. The cord felt wiry, something like a thin vas deferens; its general direction was, I should say, on a line between the left nipple and the symphysis pubis. I could trace it for a distance of about eight inches and it faded away at both ends. (Fig. 4.) It was tender on pressure, but only when pressed against a firm base, in this instance the contracted abdominal muscles. During the exami-

*I avail myself of this opportunity to express my gratitude to Doctor Klemperer for the manifold pathological examinations, as well as other favors in the course of the preparation of this paper.

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FIG. 2.—Section of inframammary cord in Case I. Low power.

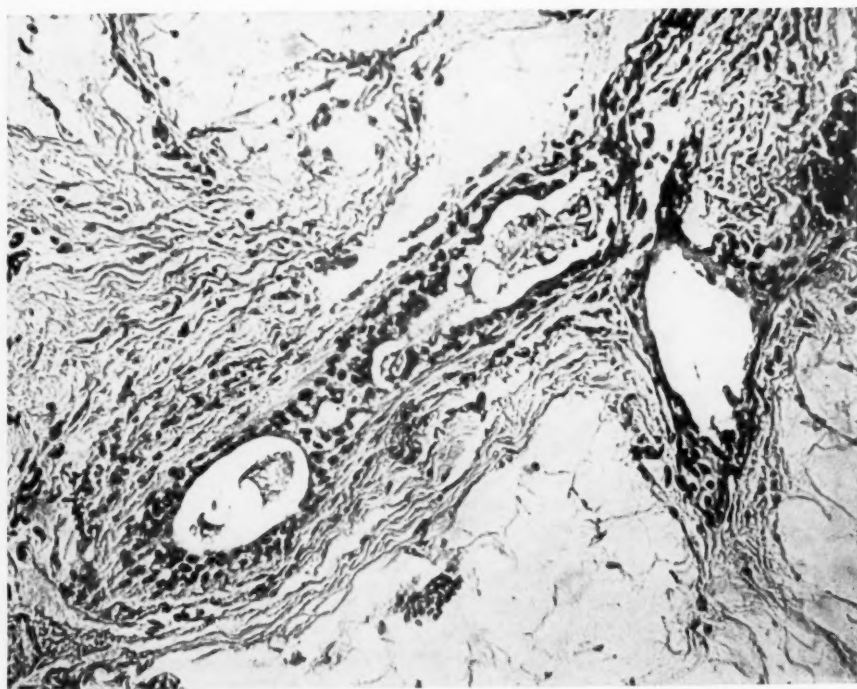


FIG. 3.—Section of inframammary cord in Case I. High power.

nation, the patient volunteered the information that this was the pain of which she complained and for the relief of which she sought advice. I repeated my examination at weekly intervals and was thus repeatedly able to confirm my findings. On reexamining the patient about six months later, I could no longer find any trace of the cord and the patient considered herself well.

CASE III.—Dr. C. consulted me in December, 1931, as to the nature of a peculiar cord which he discovered by accident in the left axilla. In reality, the discovery was not wholly accidental, because on closer questioning the patient confessed that the self-examination which led to the discovery of the cord was induced by a sense of discomfort in the region mentioned. Dr. C. considered the cord to be an inflamed lymphatic vessel, presumably secondary to a tiny pustule on the outer aspect of the arm. Some

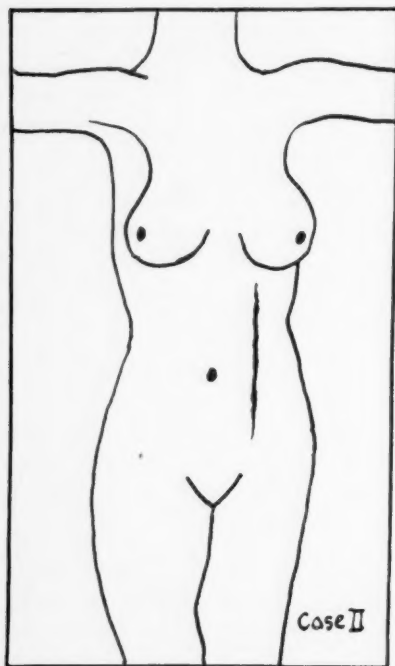


FIG. 4.—(Case II.) Note long infra-mammary cord on left side.

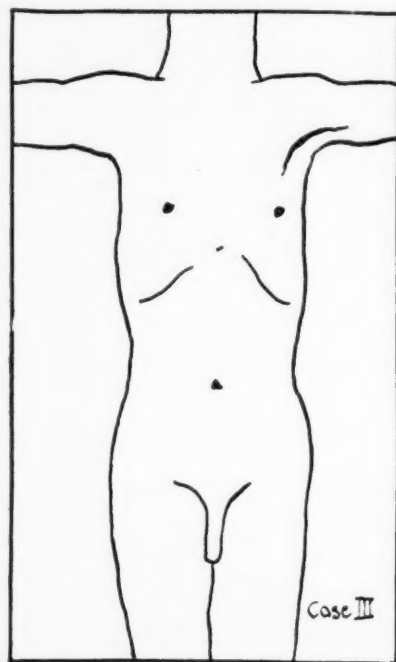


FIG. 5.—(Case III.) Note supramammary cord on left side.

time after Dr. C.'s first visit, he imparted to me the additional highly interesting information that he recollects that at the age of fifteen he was under treatment for a painful swelling of the breast, accompanied by a serous discharge from the nipple.

Physical examination revealed the pustule previously alluded to. In addition, there was to be palpated a cord-like structure about five inches in length which ran parallel with the inferior border of the pectoralis major in the anterior axillary space toward the chest-wall and then curved gradually downward towards the breast. (Fig. 5.) Both ends gradually faded away into the surrounding tissues. At this point, I again wish to emphasize that the cord was definitely subcutaneous and not intracutaneous. I can give no better description of the cord than by reiterating that it felt like an adult vas deferens. Dr. C., never having heard of such a possibility, doubted the correctness of my diagnosis and rejected my suggestion to excise a small portion of the cord for microscopical examination. Incidentally, I cannot quite blame the patient for his lack of coöperation, because I assured him that the cord would disappear in the course of

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time. My last examination took place November 12, 1932, and revealed nothing abnormal.

CASE IV.—In February, 1932, I was requested by Dr. Leon Ginzburg to see Miss R. A., nineteen years of age, a patient in the Out-Patient Department of Mount Sinai Hospital, who gave the following history: Three weeks ago, she had an attack of influenza. Shortly thereafter, she began to complain of pain in the right axillary region. To use her own words: "She felt as if she were getting a boil." Upon examining herself, she discovered a painful strand in the axilla. Physical examination revealed a cord about six inches in length in the anterior part of the axilla, which at first ran parallel with the inferior border of the pectoralis major, and upon reaching the chest-wall curved gradually downward in the general direction of the breast. (Fig. 6.) The cord felt just about like an adult vas deferens, and was rather tender. I dem-

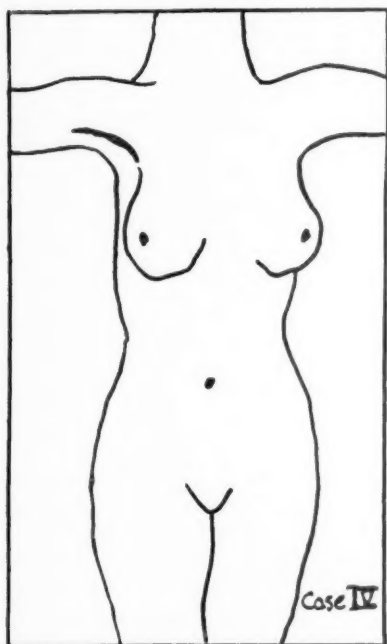


FIG. 6.—(Case IV.) Note supramammary cord on right side.

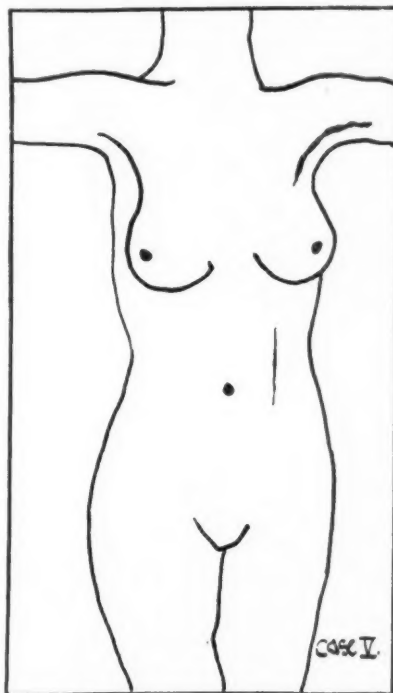


FIG. 7.—(Case V.) Note supramammary cord and inframammary cord on left side.

onstrated the patient to several colleagues who chanced to be present. When I wished to reexamine her, I made heroic efforts to trace her, but greatly to my regret, as is so frequently the case with the shifting population in a large city, I was unable to do so.

CASE V.—Mrs. Rose P., thirty-eight years of age, consulted me November 5, 1932. Several years ago, I operated upon her sister, on which occasion I extirpated a supernumerary breast from the left axilla, and she still has a supernumerary breast in the right axilla. The patient under discussion now states that for the past four years she has suffered intermittent pain in the left breast and axilla radiating down the arm. In the beginning, she was under treatment in the Out-Patient Department of the Lenox Hill Hospital. About one year ago, she noticed that she could not lift the left arm as fully as the right, nor as fully as she was able to do formerly; as she states, "because

there was something that was pulling her arm down". More recently, she was under treatment at the Post-Graduate Hospital and was advised to discontinue the use of her arm and to report in two weeks. Her pain, general discomfort and functional disability continued unabated.

My physical examination revealed the following status of interest: When the patient was requested to elevate the left arm, she was unable to do so as completely as on the opposite side. This disability was caused by a strand of tissue which was not only palpable but also visible, which ran in the anterior portion of the axilla from the chest wall toward the humerus and was apparently quite taut. The strand of tissue felt about the size and consistency of an adult vas deferens and was rather tender. It was about five inches long; these measurements are only approximate because I could not

follow the cord toward the breast quite as readily as in some of the other cases. It was distinctly subcutaneous and not intracutaneous. I presented the patient to several colleagues. One was inclined to doubt my tentative diagnosis and suggested that the strand of tissue palpated might be the tendon of an abnormal slip of the pectoralis major. Continuing my examination, I believe I also felt two short cord-like strands in the subcutaneous fat of the anterior abdominal wall, running in a sagittal direction in the nipple line of the left side, but I am not fully convinced that this observation was correct. (Fig. 7.) I have seen the patient several times since and at each examination could verify the correctness of my various observations. I suggested an excision of the cord to the patient, being convinced that this procedure would free her from all her complaints, but thus far have failed to gain her consent to an operation.

The case just described is exceptionally noteworthy, because we are dealing with two sisters, both of whom show an abnormality in the development of the breast; one sister has bilateral supernumerary axillary breasts while the other sister has an inflamed vestigial mammary structure.

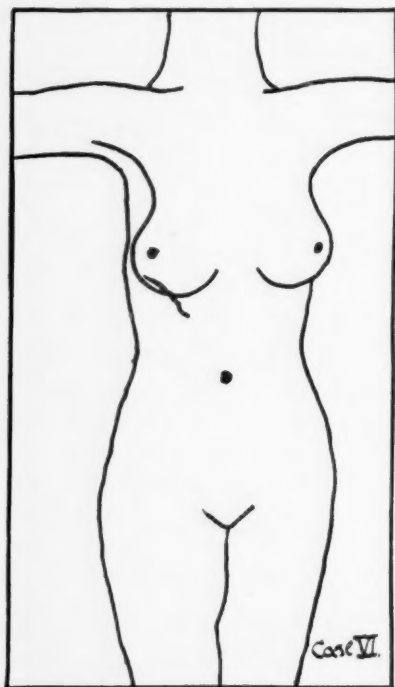


FIG. 8.—(Case VI.) Note short diagonal inframammary cord on right side.

CASE VI.—December 9, 1932, I was invited by Doctor Brettauer to see Mrs. R. H., who had consulted him about some uterine trouble. She was suffering from dysmenorrhœa and had frequent attacks of mild peritonitis. She availed herself of the opportunity to also show Doctor Brettauer a cord-like structure located below the right breast. This cord had existed for a number of years and was painful from time to time, particularly during her menstrual periods.

On examination, I again found a peculiar cord about two and one-half inches in length which began at the periphery of the right breast, not, however, in the nipple line but a trifle to the right of it (Fig. 8); nor did it run in the general direction of the symphysis pubis, but more toward the umbilicus. I am therefore not convinced of the correctness of the observation in this case. I am inclined to include it, however, for the reason that it presented most of the characteristics of the other cases and also on account of the pain and tenderness in the cord during her menstrual periods. Doubt is created in my mind only because of the direction of the cord which was not quite

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as it existed in other cases, namely, toward the symphysis pubis. Doctor Brettauer expects to operate upon this patient for her uterine trouble; at the same time, he intends to excise the cord under discussion for pathological examination.

Symptomatology.—A careful survey of these six histories reveals a comparative lack of symptoms; those few symptoms that are present, however, are very definite and striking. The outstanding feature of all these patients and the one I wish to particularly emphasize is that each one is an actual and actively complaining patient who seeks relief for a very definite ailment; in other words, the physical signs to be shortly described were not merely accidental findings in otherwise healthy individuals. In the main, the principal complaint of these patients is either pain or functional disability, or both, either below the breast extending for a variable distance upon the abdomen, or above the breast extending towards the corresponding shoulder and axilla. Pain was present in all cases but was rather severe in Cases II, V, and VI. The functional disability, as might be surmised, was more pronounced in the three supramammary cases and was an outstanding feature in Case V. This is just what might have been expected on account of the anatomical location of the lesion, the region of the shoulder, which is much more liable to slight traumatic insults than the soft tissues of the abdominal wall.

Physical Signs.—The preëminent physical finding is the presence of a cord-like structure in certain characteristic locations and only in these, namely, either upon the abdomen or on the thorax and axilla or both.

The cords are found only in the course of a very narrowly circumscribed line which begins in the lateral part of the axilla and runs towards the chest; upon reaching the chest, the line curves downward to reach the upper border of the breast in the nipple line. This part of the line may therefore be called the supramammary part of the line. The inframammary portion of the line begins at the inferior border of the breast in the nipple-line and runs, slightly converging towards its fellow of the opposite side, in the general direction of the symphysis pubis. (Fig. 9.)

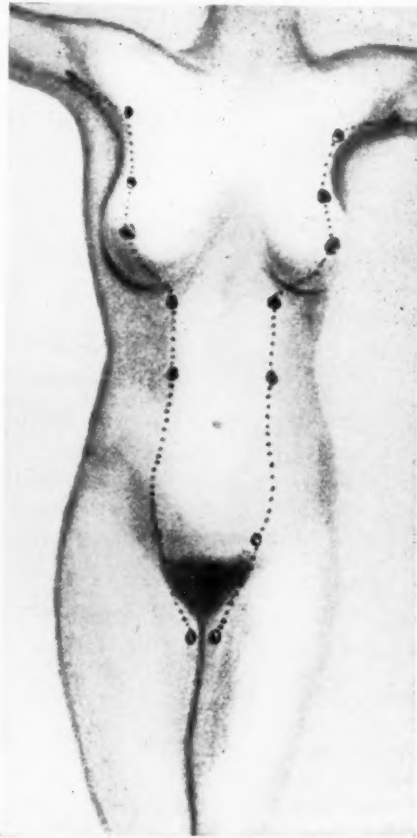


FIG. 9.—Outline of milkridge after Dietrich and Frangenheim¹. (After Merkel.)

The cords vary in length; nor can the length be measured accurately because they tend to fade imperceptibly at both ends into the surrounding tissues. Some of the cords I have observed were very short, not more than two or three inches, while others were quite long, up to eight inches or more. It is not an easy matter to give an accurate description of the cord; the best way I can describe it, perhaps, is to compare it to an adult vas deferens, because of the sensation which it imparts to the examining finger. A few of the cords were somewhat thinner than that. During what might be termed the more acute stage of the illness, these cords were quite tender, but with the subsidence of the acute period, the space previously occupied by the cord lacked all tenderness, as might have been expected; as a matter of fact, it cannot be differentiated from the surrounding tissues.

The lesion exists in both sexes. Case III was in a male. Apparently, however, it is much more frequent in the female sex; in the six cases reported in this presentation, the ratio was as five to one. I have already indicated that the localization of the cords in question is confined within very narrow limits. I have encountered them on both the right and left sides; always, however, on the anterior surface of the chest and abdomen and never on the back or sides.*

If the location, direction, in fact entire topography of the line are studied, it becomes evident that there must be some anatomical basis for this peculiar and one might almost say, spectacular distribution; and yet, up to the present time, at least, nothing of the kind has ever been described as existing in post-natal life. In order to find a correct explanation of this peculiar distribution, it is essential that we trace the embryology of the breast.

Embryology.—The entire embryological development of the breast is interesting. It is not my intention, however, to describe it at great length, because only one very brief phase of it, namely, the one that exists only in a fifteen-millimetre embryo is germane to the subject under consideration at present. Those interested in the later stages are referred to the masterly monograph by Eggeling² which brings the subject practically up to date and has the additional merit of a very complete bibliography. Prior to 1892, our knowledge of the early development of the breast was limited to the stage of the papilla and bud formation; nothing whatever was known of the various preceding stages. In the year 1892, O. Schultze³ described a much earlier stage in the development of the breast in a series of animals, namely, in pigs, rabbits, cats, foxes and moles. Schultze reports that he saw in a fifteen-millimetre† embryo, a line which ran from the attachment of the plate of the anterior extremity to the attachment of the plate of the posterior extremity. He describes the line as being very narrow and as being slightly

* This is not quite as self-evident as might be expected, because in some mammals, for instance, in certain members of the hippopotamus group, the normal breast is located not upon the ventral surface of the body, but well over on the side. This is a rather wise provision of nature, as it enables the young, usually carried upon the back of the mother, to suckle even when the mother is partially submerged in water.

† Whenever measurements of embryos are quoted in this article, it always means nape-breech length.

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elevated. Schultze called this line "Milchlinie" or milkline, although he adds that "Milchleiste" or milkridge, would perhaps be a more appropriate name. Subsequent writers on this subject are not entirely in accord as to the proper nomenclature, as some speak of a milkline, others of a milkridge and still others use both terms indiscriminately. My knowledge of embryology is too meagre to give me the privilege of taking sides in this controversy. It appears to me reasonable, however, to call the very earliest stage of the structure a milkline ("Milchlinie") and subsequently, when it has attained an appreciable thickness, to call it a milkridge ("Milchleiste").

The next contribution of importance is that of Hugo Schmidt,⁴ who, having been interested mainly in the question of supernumerary breasts and nipples, approached the problem from a slightly different angle. Schmidt's article, although quite short, is a very valuable contribution to the question; it is regrettable, however, that his article, owing to many apparently contradictory statements, lacks conviction in some respects. Thus, for instance, if I understand properly a rather involved sentence on p. 702 of his article, he goes so far as to deny even the existence of a milkline. The only saving clause is that he qualifies his negating statement by adding the words, "at least, not to the extent described by him (Schultze)." He examined human embryos of the proper size for the presumed Milchleiste, which had already been discovered by Schultze in pigs and other animals, and definitely states that he failed to find one. In my estimation, no valid reason whatsoever exists for making such a statement because he promptly reverses himself when, in the further course of his description, he states that he saw in the anterior axillary line of two embryos a line running downward for one to two millimetres which was lighter in color and which may have been a Milchleiste.

The two embryos examined by Schmidt were fifteen millimetres long. In the first embryo, he saw a line on the left side under a magnification of seven diameters; it was short and comparatively thick. In the second embryo, it was not quite so distinct, but judging solely by his description, Schmidt must have seen it, because he definitely states that he observed the line divide at one point, and in addition, saw in the line of division an oval area which became more conspicuous because of its darker color.

No such line was to be seen in larger embryos, namely, those of seventeen to thirty-four millimetres.

Schmidt made his most interesting and valuable contributions when he studied his material microscopically. He made serial sections parallel to the long axis of the embryo, which began at the axillary end of the line and progressed towards the midline. In this manner, he discovered in addition to the anlage for the main mammary gland eight other, although smaller anlage, which he designates as supernumerary mammary anlage. The outermost one of these was near the axillary end of the line.

It is rather important to bear in mind that Schmidt made his microscopical sections parallel to the long axis of the embryo, because in this manner he discovered that the additional mammary anlage cephalad to the main mammary anlage were to the outer side of the nipple line; while those situated caudad were internal to the nipple line. Schmidt made, as already stated, his sections parallel to the long axis of the embryo and by subsequent reconstruction he was enabled to map out the peculiar course of the line. The great merit of Schmidt, therefore, is that his contributions laid the foundation of our knowledge of the peculiar topography of the milkline in the human body.

In spite of Schmidt's denial of having seen a macroscopically visible milkline in his embryos, it appears quite conclusive to me that he must have done so. Be that as it may, all subsequent writers on this subject generally give credit to Kallius for having been the first to see a milkline in a human embryo.

Kallius⁵ was the first person to see the analogue of Schultze's milkline on a fifteen-millimetre embryo. The cue to it was its lighter color. He stated that on the right

side he saw a ridge-like elevation, which began about 0.25 millimetres below the attachment of the anlage to the upper extremity. It was situated approximately in the mid-axillary line and was about 1.5 millimetres long. As it descended it gradually faded away, and, in consequence, the lower limit of the line was not as sharply demarcated as the upper. The entire width of the line was about one-third millimetre. Kallius furthermore states that he had difficulty in measuring the exact height of the line, but he estimated it to be about 1.5 millimetres. At all events, it was thick enough to cast a shadow when properly illuminated. With negligible variations, the line on the left side was similar to the one on the right.

Microscopically, this ridge-like elevated line proved to be, throughout its entire extent, a distinct thickening of the epidermis, of varying width and depth, and composed of layers of cylindrical cells. Kallius quite justifiably looks upon this even microscopically readily visible line or ridge as the very earliest anlage of the breast. Subsequently, a true breast forms only from a comparatively minute portion of the line and he surmises that the remainder of the line disappears. It is rather interesting to note the importance of the early development of the breast, as Kallius estimates his



FIG. 10.—Embryo after Kallius,* right side.



FIG. 11.—Embryo after Kallius*, left side.

embryo to be, at most, thirty to thirty-four days old. (Figs. 10 and 11.) Kallius is of the opinion that, at least in the human embryo, the milkline appears very rapidly and disappears just as rapidly, but he offers no evidence of having actually observed it. His assumption of the disappearance of the human milkline has, however, a rational basis, because a process of a similar nature has been observed in pigs.

Chronologically, the next contribution of importance is that by Heinrich Schmitt,⁶ in which he confirms the observations of O. Schultze, Hugo Schmidt and Kallius. He is rather scrupulous in giving Kallius the credit for having discovered the enormous extent of the Milchleiste, over such a large surface area of the embryo. Schmitt describes the subsequent development of the breast and finally adds the significant statement that considering the fact that the breast develops only from a comparatively small portion of the Leiste, the remaining portion of this embryonal structure must, in the course of further development, undergo retrograde changes. Both Schmitt and Kallius are of the opinion that the long caudal portion of the Leiste* not utilized in the development of the normal breast is very probably the precursor of supernumerary breasts. As a matter of fact, he literally makes the statement that he actually saw occasional structures in older embryos which gave him the impression of a temporary

* Kallius, as accident will have it, made his observations on a mutilated embryo, the head having been severed in transit. The head shown in outline in his illustration, which accompanies this article (Fig. 10), was drawn in subsequently, after comparison with His' Normaltafeln.

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hyperthelie. Whenever supernumerary breasts and nipples develop, they are always located in the course of the Milchleiste.

The last decade of the nineteenth century was peculiarly prolific in articles dealing with the various stages of the development of the breast. The majority of these contributions are, in the main, confirmatory of preceding observers; very little is to be gained, therefore, by quoting these at greater length. Full meed of credit, however, must be allotted to the truly astonishing observations of Ernst Bresslau⁷ who has done perhaps more than anybody else to clarify the comparative embryology of the mammary gland, having studied the subject most carefully and assiduously in the three principal mammalian groups, namely, in the monotremes, marsupials and placentals. I want to mention Bresslau's contribution particularly, because in his discussion of the mammary development of bats (who like humans, have only one pair of breasts, namely, pectorals) he states that he saw a Milchleiste in a five-millimetre embryo, the cephalic end of which forms the definite anlage of the breast, and he casually adds the significant remark "that the rest disappears."

Bresslau concludes his article by propounding the hypothesis that the epidermis in those locations where the milkline existed in the embryo never loses its primary inherent property, in consequence of which it always retains the power to proliferate at some future time. I cannot fully subscribe to this proposition in the present state of our knowledge. In my judgment, it would be rather hazardous to venture an opinion in the question as to whether a supernumerary breast, which is perhaps discovered for the first time at puberty or during lactation, has just been formed or whether it has existed in a dormant and undeveloped stage for a long time; on the contrary, to me, it appears rather probable that the latter is more likely.

The numerous articles that have appeared since the epochal discoveries of Schultze and Kallius are in the main casuistic contributions to the subject of hypermastie and hyperthelie. Deaver and McFarland,⁸ in their monograph on the breast, have compiled a notable series of these and other abnormalities of the breast. These authors deserve the greatest credit for a monumental work.

To recapitulate, we may accept as proven

(1) There exists in embryonic life (seen in fifteen-millimetre embryos and in a few instances in even smaller embryos) a line which is the earliest anlage of the breast.

(2) This line has a very definite localization. Roughly speaking, it extends from the axilla to the symphysis pubis.

(3) Although this primitive line is very long, a true breast in the human species develops only at one point, namely, in the pectoral region.

(4) When abnormalities occur, *e.g.*, hypermastie or hyperthelie, these abnormal structures are always located in the course of this line. The very rare exceptions reported as having been encountered in other parts of the body lack all acceptable scientific proof.

(5) There are only surmises as to what becomes of that apparently superfluous part of the line which does not enter into the formation of the breast. Most authors do not discuss this phase of the subject at all. A few, for instance, Lustig⁹ or Heinrich Schmitt,¹⁰ mention only casually that the milkridge regresses or that it disappears, but no one brings proof of having actually observed it.

O. Schultze, in his discussion of the development of the breast in animals, ventures a little further; at least, he states that at a certain stage there begins a resorption of that part of the milkline which exists between primitive tits.[†]

(6) Finally, up to the present time at least, no one has observed a persistence of the milkline or any part of it in post-natal life.

Since becoming interested in this subject, I have had the good fortune to observe six cases of what I consider to be persisting milklines, so altered

*Why not also the cephalic portion?

† Not to be confounded with the ultimate teats.

pathologically as to be recognizable by simple palpation. The question quite naturally suggested itself to me as to the frequency of the persistence of shorter or longer portions of the milkridge in human beings which are not changed pathologically and which, in consequence, escape all detection. For aught anybody knows, it may be a very common occurrence or perhaps it exists undetected in most individuals like many another vestigial structure, for instance, the organ of Rosenmuller or the hydatids of Morgagni. I have discussed this problem with anatomists and have even suggested investigation of the subject. Such an investigation, I have been advised, would entail an amount of labor and expense which does not appear warranted for the time being.

If we now recapitulate my clinical and scanty pathological observations and correlate these with the present-day accepted knowledge of the embryology of the breast, we must inevitably arrive at the following conclusions:

(1) There exists in certain individuals an abnormal persistence of the milkridge in some part of its normal course.

(2) Such a persisting milkridge is absolutely symptomless and is therefore not discoverable.

(3) For some reason or other, this abnormally persisting line may become changed pathologically (I presume inflamed, judging from the one section I have been able to study) and it then gives rise to the various symptoms and physical signs I have enumerated in another portion of this paper, in consequence of which it becomes discoverable.

(4) Finally, one must also arrive at the conclusion that if the lesion were discoverable or had actually been discovered, it has not been hitherto recognized.

Just a few words in explanation of the name "Vestigial Mastitis." I have searched for a name which would be both descriptive and accurate. The disease in the present state of our knowledge is some kind of pathological process, let us say inflammatory, in a vestigial structure. Strictly speaking it is not a mastitis, and yet the cells which enter into the formation of the structure are so much akin to mammary epithelial cells that the word mastitis appears to be justified. I am indebted to Dr. Howard Lilienthal for the excellent suggestion of a descriptive name.

A word of apology for the paucity of the pathological material submitted by me in confirmation of this thesis. I have done my utmost to persuade more patients to consent to operation, but, as is evident, I have not been very successful. At the same time, the one case which was examined pathologically is, to my mind, so conclusive that it goes very far in confirmation of my theory.

I am sure it does not require more than passing mention that I have searched the surgical literature very thoroughly for reports of similar cases and that I have failed to find anything even remotely suggestive.

At the conclusion of my presentation, I wish to express surprise that this practically superficial lesion has escaped all notice up to now. This cer-

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tainly has been my experience in a rather active surgical career of many years.

I have been much interested in this subject during the past three years, and now that I have called attention to it I trust that my findings will be confirmed by future observers.

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DISCUSSION.—DR. HOWARD LILIENTHAL (New York City) said that he had one patient who had this peculiar vas deferens feeling in the arm just anterior to the axilla. He thought it was lymphangitis. He sent her to Mt. Sinai Hospital in the ward service where a small adenofibroma was excised. The vestigial mastitis disappeared and they lost the opportunity to investigate it.

He believed that this diseased condition exists oftener than surgeons have any idea of. Of course, the embryonal tissue probably exists frequently but inflammation must be present before one can feel it objectively. Biopsies should be more often made.

He said Doctor Moschcowitz seems to have revealed his anxiety to get the specimen more than he should have, or the patient would have consented. If he had told her he didn't know what the disease was, and that it was important to make a diagnosis, he might have had a chance to excise the specimen.

Anything one cannot recognize and diagnose ought to be investigated. It is perfectly proper to inform the patient and make him—or her—understand the importance of diagnosing with accuracy.

DR. EDWIN BEER (New York City) said that he had seen one of these cases in Doctor Moschcowitz's office. This is a new clinical entity and according to the comparative anatomist there is a very definite anlage from which these various structures may develop. Whether it is a frequent occurrence or not, or whether one finds such cases, as so often happens, after looking carefully, he did not know.

Yet so many new clinical entities have been described in the last thirty years—entities which had not been recognized—that this type of mastitis might belong to the same group.

DR. ALEXIS V. MOSCHCOWITZ (New York City) said he had been working on this subject for the past two or three years. The hard part is that here is a lesion which is absolutely superficial. It is subcutaneous. One can feel it and palpitate it. If one is on the lookout for it he was sure one would find it.

With regard to the pathology, in order to be absolutely certain, he sent the sections abroad and they had them examined by Professor Pick in the University of Berlin. He absolutely agreed with his findings.

SKELETAL PATHOLOGY OF ENDOCRINE ORIGIN

By MAX BALLIN, M.D.

OF DETROIT, MICH.

THE connection respectively between calcium phosphorus metabolism and parathyroid pathology is well established by many post-mortem findings of osteomalacia coincident with parathyroid tumors, by the now frequently repeated experimental production of osteomalacic symptoms, especially osteitis fibrosa cystica generalisata (the main skeletal change in parathyroidism), by the injection of large amounts of parathyroid hormone, and last but not least, by the cure of such osseous softening which follow the surgical removal of parathyroid tumors (hyperplasias or adenomata). With this new information on parathyroid pathology and the knowledge of the connection between islet tumors and hyperinsulinism, between adrenal tumors and paroxysmal hypertension, between basophile adenomas of the pituitary and plethoric adiposity (Cushing's syndrome), *etc.*, *etc.*, it seems at times that this fascinating study of the endocrine glands now offers a definite understanding of their function. But then again so many observations contrary to this seemingly acceptable physiology of the endocrines appears that the present knowledge after all is still unsatisfactory. The main factors clouding the question are the interrelation of functions and the substitution of one gland for another in temporary or lasting deficiencies, polyglandular upsets existing with or following the breakdown of one type of glands. Perhaps, also, the governing influence of pituitary hormones on the function of the other endocrines, as has been proven by experiments and clinical observations, is such a factor in rendering the endocrine functions hard to understand. In the gross physiology of endocrine glands the following data are outstanding enough to be acceptable according to our present knowledge:

- (1) The thyroid is in control of basal metabolic rate, combustion of carbohydrates, fats and proteids (the last still doubtful).
- (2) The parathyroids are in control of calcium and phosphorus metabolism.
- (3) The pancreatic islets are in control of sugar metabolism.
- (4) The pituitary is in control of growth, fat, pigment, sexual development, *etc.*
- (5) The adrenals are in control of blood-pressure, muscular tonicity, *etc.*

This tabulation suffices for a few classical cases in each group; but then we hear of diabetes of thyroid or pituitary or renal origin without apparent pathology in the islets, of an upset in calcium without any parathyroid pathology or of symptoms partially thyroid, partially adrenal in character. Recently an important article by Wilder²⁰ treats of "Polyglandular Dyscrasias Involving Abnormalities of Sexual Characteristics." The title

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could just as well have read "Polyglandular Dyscrasias Involving Abnormalities of the Skeleton," as it will be impossible to separate, for instance, the sexual symptoms and the osseous symptoms in polyglandular upsets. There are always several rows of outstanding symptoms. Our discussion will concern upsets in calcium and phosphorus metabolism; in other words, skeletal changes caused by endocrine disturbances. Obviously, here also other symptoms have to be brought in if for no other reason than for differential diagnosis. To be sure, the parathyroid undoubtedly is responsible for most of the endocrine skeletal changes, but a good many cases are now known of skeletal changes in other endocrine conditions that a classification as to their differentiation seems to be desirable. It will be difficult to limit this discussion to processes plainly endocrine in origin; a few metabolic disturbances are closely related to endocrinopathy without any endocrine connection being known so far.

Besides, (1) parathyroidism, we will consider: skeletal disturbance in (2) thyroidism; (3) and (4) thymus and pituitary pathology; (5) after loss of ovarian function, *etc.*; (6) pancreatic and suprarenal polyglandular syndromes; (7) xanthomatosis (lipoid upsets); (8) renal rickets, leukæmic and splenic conditions and biliary fistulas.

A. Skeletal Disorders Due to Faulty Nutrition

AVITAMINOSIS

	Main Symptoms	Gen. or Local	Pathology	Serum		Etiology	Para- thyroid	Treatment
				Ca	P			
(1) Rickets. Infantile	Deficient calcification of osteoid tissue during ossification	General	Decalcification, irregular enchondral ossification. Tetany rare	8 Rarely 6	2 Low	Food deficiency and avitaminosis	Hyperplastic functional adaptation	Dietary Vitamines Calcium Light
(2) Osteomalacia. Adult	Deficient calcification of osteoid tissue after ossification	General	Decalcification. Tetany frequent	5 to 7	1.8 to 3.5	Food deficiency and avitaminosis, starvation; pregnancy	Hyperplastic functional adaptation	Dietary Vitamines Calcium Light

Before entering the discussion of the purely endocrine disorders the skeletal dyscrasias due to faulty nutrition, avitaminosis, and so forth will be briefly mentioned, as they are closely related. The differential points are as follows:

(1) Rickets is an attribute of the growing age, usually of infancy, less of adolescence. The affection is nearly always general throughout the whole skeleton and especially affects the growing epiphyseal lines where growth and calcification mainly take place. Serum calcium and phosphorus are but little altered and if so moderately diminished.

(2) Osteomalacia is but an adult type of rickets following faulty nutrition, hunger as in war times, and deficiency in vitamins due to inability to

get properly proportioned foods; this is more harmful when an increased demand for calcium production exists, as in pregnancy.

Dietary measures will usually cure rickets and osteomalacias (proper food, vitamins, light, *etc.*) in so short a time that such feeding and treatment may be used as a therapeutic test in doubtful cases. The enlargement

of the parathyroid present in rickets and osteomalacia is a compensatory one; the glands become hyperplastic in order to meet the greater demand for their hormone so important for proper calcium and phosphorus metabolism. As the compensatory goitre of puberty becomes permanent at times under endemic and hereditary influences, this compensatory parathyroidism in rickets and osteomalacia at times also leads to permanent parathyroidism.

(1) *Parathyroidal* osteomalacic changes are the most outspoken of endocrine osteopathies. Cases of parathyroid adenomas or hyperplasias with changes in the bones are now so frequently described that the entity is well established. One hundred and fifty to two hundred cases are mentioned in the literature of the removal of such tumors or hyperplastic glands with an influence from improvement to clinical cure. Under the influence of increased parathormone production calcium is liberated from the skeleton, hypercalcaemia and skeletal decalcification ensue. The main osseous alterations of parathyroid origin are general and



FIG. 1.—Progressed case of parathyroidism. Note decalcification of skull with disappearance of bony limits, giant-cell tumors (osteoclastomas) in long bones. (Max Ballin and P. F. Morse, *Amer. Jour. Surg.*, vol. xii, No. 3, pp. 403-416 June, 1931.) For other instances of parathyroidal skeletal pathology see Fig. 5.

localized decalcifications. In the general type the bones look as if they were underexposed, in the röntgenogram in extreme cases the bony limits are dimmed, but nearly always this general deficiency of calcium is accompanied by localized fibrocystic areas. These areas are sometimes minute, giving, for instance, to the skull a general granular mottled appearance. In other cases

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larger cystic areas form containing osteoclastomatous, giant-cell tissue; deformities, curvature of the long bones, compression of the vertebrae and fractures follow so that we have a very characteristic picture of a parathyroid osteitis, or osteosis as Lièvre¹⁵ calls it (in order to avoid giving the impression of any inflammatory process he prefers osteosis to osteitis).

At the same time the changes in the blood calcium are more or less pronounced, the serum calcium being increased from a normal of eight to ten milligrams per 100 cubic centimetres up to twelve and even twenty-three milligrams. The normal serum phosphorus of three to four milligrams falls to two to one milligrams and less. Muscular weakness, calcinuria, metastatic calcium deposits, and so forth, are other symptoms of this special osteomalacic type. There are enough characteristic symptoms so that a diagnosis may be positively made in a great majority of cases. (Fig. 1.)

B. Skeletal Disorders Due to Endocrine Pathology

I. PARATHYROIDISM

Main Symptoms	Gen. or Local	Pathology	Serum		Etiology	Para-thyroid	Treatment
			Ca	P			
General decalcification, osteitis fibrosa cystica with localized cystic or osteoclastomatous areas, deformities, fractures	General and localized	Osteitis fibrosa cystica, giant-cell tumors and cysts in bones. Adenomas and hyperplasia of parathyroid	12 to 23	0.6 to 3	Hyperfunction of parathyroid due to adenomas or hyperplasia of gland	Adenomatous or hyperplastic	Parathyroidectomy (radiation) and medical care as indicated (calcium, vitamin D, etc.)

(2) *Thyroidism* is accompanied by markedly increased calcium excretion (Aub, Bauer, Heath and Roper¹). This increase in the elimination of calcium has been reported in one case 231 per cent. above normal; in another case eight times normal values were reported. The same increase in calcium excretion may be produced experimentally by feeding thyroid extract and this increased excretion of calcium returns to normal if the patient or experimental animal is treated with Lugol's solution or if the exophthalmic goitre is removed. In toxic adenomas the calcium excretion is not as much increased as in exophthalmic goitre, but the increase may go up to twice normal values, likewise returns to normal with removal of the adenomatous goitre. In myxœdema, the opposite, the calcium excretion is diminished (the thyroid treatment of tetany is based on this observation).

In spite of the increased calcium excretion in thyroidism there is no hypercalcemia present as in parathyroidism and this is an important distinguishing factor. In the thyroid type the increased calcium excretion is urinary and fecal. The phosphorus also takes part in this increase. Kummer¹⁴ has shown this increase of calcium excretion in exophthalmic goitre accompanied by marked decalcification of the skeleton, but this osteoporosis in thyroidism is a general one in opposition to the lacunar resorption in parathyroidism leading to the peculiar mottled appearance of the bone, in

pathological terms to osteitis fibrosa cystica. The general decalcification in exophthalmic goitre is rarely complicated by a mild lacunar resorption and then we probably have to think of a combination of thyroid and parathyroid disturbance (Fig. 2 A, B, C).



FIG. 2.—Note the plain osteoporosis in exophthalmic goitre (B) compared with the calcification of a normal hand under the same exposure (A), versus a hand in a case of parathyroidism with localized rarefaction and giant-cell tumor (C).

B. Skeletal Disorders Due to Endocrine Pathology

2. THYROIDISM

Main Symptoms	Gen. or Local	Pathology	Serum Ca P	Etiology	Parathyroid	Treatment
General decalcification (with only slight lacunar resorption)	Mostly general. Very few localized areas	Goitre: adenomatous or hyperplastic thyroid. Decalcification of bones (no osteitis fibrosa cystica)	Normal; no increase in spite of increased excretion of both	Thyroidism causing increased Ca and P elimination 2-8 times normal amount in faeces and urine due to high B. M. R.	No changes but adenomatous processes are not infrequent in both thyroid and parathyroid	For thyroidism (surgical, radiation, medical)

(3) *Thymus* (Fig. 3).—The thymus was for a long time considered as mainly responsible for rachitic and osteomalacic processes. Klose,¹³ Matti and others described such changes after experimental removal of the thymus; irregularities of the epiphyseal zones, thickening and widening of epiphyseal cartilages, followed by compression of the cartilaginous area, osteoid tissue filling the narrow cavities, thinning the cortical substance and spontaneous fractures occurred. Other investigators could not confirm these experiments (R. D. McClure¹⁶) and the importance of the thymus in these processes was doubted. We have operated on children with osteochondritic and fibrocystic changes around the epiphyseal lines resembling parathyroidism, and in three patients we found large thymus remnants in the lower deep cervical triangles. Hyperplastic parathyroids were encountered besides the thymus in one of these three cases. The large thymus, three by two centimetres, was resected. The results of these operations we will discuss at some future time after longer observation. It seems to us so far that there is some connection,

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besides the well-known embryological relation of thymus and parathyroid, and that in children at least some relation of function exists also influencing bony growth. Bergstrand⁴ has extensively written of the thymus-parathyroid



FIG. 3.—Tumor of thymus and parathyroid (girl of six years). Osteitis fibrosa cystica of femur, skull. Fracture through cystic area, coxa vara. A definite compact hyperplastic parathyroid and a large hyperplastic thymic nodule with many Hassall's corpuscles, some of them calcified without oxyphile cells, were removed. Decided improvement. In one other similar case only a thymus tumor was found.

combination. We have found a very large thymus also in a seven-year-old boy with typical osteogenesis imperfecta.

(4) *Pituitary Skeletal Changes.*—Since Pierre Marie's work on the pituitary origin of acromegaly, the acromegalic skeletal changes with pituitary tumors have been known. More recently a group of changes has been observed in another pituitary syndrome. In modern pituitary pathology dis-

tinctions are made between the symptoms produced by the anterior and posterior lobes and also between the different cell groups, the chromophobe and the chromophile, and in the latter case the acidophile and basophile groups. From a functional point of view a distinction between hypo- and hyperpituitarism is also made. Erdheim,⁸ Berblinger³ and, in our country, the lucidly written essays of Harvey Cushing⁷ have contributed to the understanding of this chapter. For our purposes it will be sufficient if we take up the skeletal disorders: (a) those due to chromophobe adenomas of the anterior lobe of the pituitary, under which group acromegaly is the prominent representative, and (b) the basophile adenomas of which basophilism, by some now called Cushing's syndrome, is the main clinical entity.

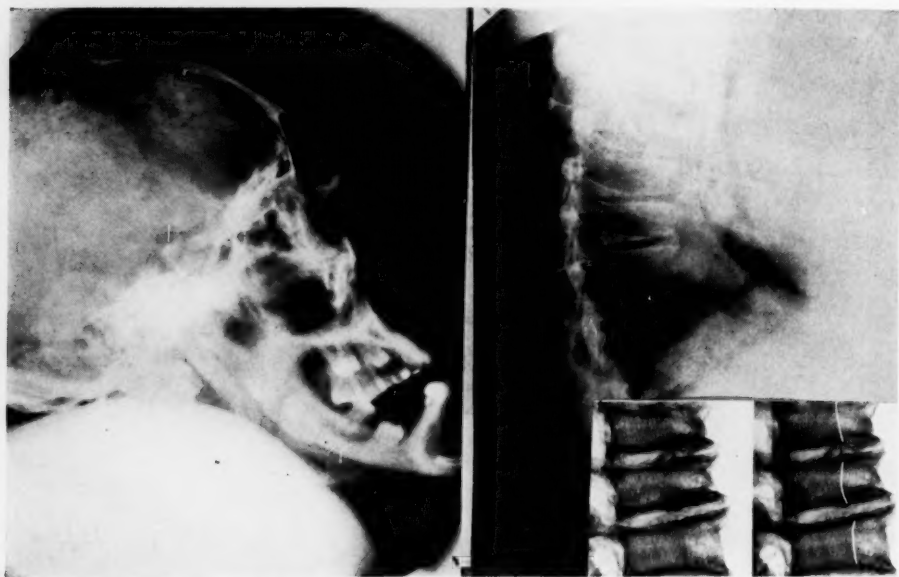


FIG. 4.—Acromegalic skull and spine. Note immense jaw and supra-orbital ridge; in temporo-parietal region some fibrocystic changes as in parathyroidism. The vertebrae are flattened. Insert (from Erdheim⁸) shows the periosteal new bony addition to the vertebral bodies. The white line shows the limit between the original body and the acromegalic addition. At autopsy a large hæmorrhagic cystadenoma of the anterior pituitary lobe, also a suprarenal adenoma, were found.

The skeletal changes in acromegaly (a) are hyperostosis of the skull, clubbing of the phalangeal ends and periosteal thickening of the vertebral bodies. The spines of such patients show kyphosis and a flattening of the vertebrae anteriorly so that they resemble grossly the spine in parathyroidism with this compression of the bodies. In acromegaly, however, the vertebrae show new bone formation entirely different from that seen in parathyroidism. The acromegalic vertebrae show anteriorly new bone forming, always distinguishable from the old part of the vertebrae by a demarcating line. No such new formation takes place in parathyroidism where the bone simply collapses from lack of lime (compression fractures), whereas the acromegalic vertebra is flattened and broadened and increased, especially anteriorly, in the circumference of the body by the newly formed, though less weight-

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bearing bone. (Fig. 4.) Furthermore, the acromegalic bone changes are accompanied by increase in the size of the hands, feet, jaw and frontal supra-orbital ridges and this growth is not limited to the bones alone but also affects the soft parts, thus placing the acromegalic skeleton in a class by itself.

The serum calcium is usually normal, although in one of our late cases we have seen a calcium of 12.6 milligrams, but autopsy in this case, as so frequently, showed polyglandular changes, small adenomas and hyperplasias of the parathyroids and an adrenal adenoma. In a pure case of acromegaly there seemed to be no changes in the serum calcium and serum phosphorus.

B. Skeletal Disorders Due to Endocrine Pathology

3. PITUITARISM

(a) Chromophobe (b) Basophile Adenoma (Cushing's Syndrome)

Main Symptoms	Gen. or Local	Pathology	Serum		Etiology	Para-thyroid	Treatment
			Ca	P			
(a) Acromegaly. Giantism	General and local	Hyperostosis of skull, clubbed phalangeal ends, periosteal thickening of vertebral bodies, etc.	Normal or slight increase	2.7 mgs.	Chromophobe adenomas of anterior lobe of pituitary	Secondary adenomas or hyperplasias	Surgical
(b) Basophilism, hypertension, acrocyanosis, adiposity face, neck and trunk, striae, decalcification, kyphosis, etc.	General and local	Basophile adenomas of anterior lobe pituitary. Secondary osteitis fibrosa cystica of skull, vertebrae, etc.	9.8 to 12.6 mgs	Normal Greatly increased calcium output 840 in 24 hrs. urine (vs. 186 normal). Increased cholesterol to 250 (vs. 180 normal)	Basophile adenomas, secondary hyperplasias in thyroid, islets and parathyroid		Radiation of pituitary gland

In the second group (b) of pituitary disorders, the basophile adenoma of the anterior lobe of the gland, Cushing⁷ has collected fifteen cases, some of his own and some from the literature, and in these decalcification and osteoporosis were shown in the X-ray six times, thoracic kyphosis, loss of height twice, spontaneous fractures in two cases. At post-mortem examination osteoporosis, especially of the spine, was reported six times, whereas in two post-mortems no reference has been made to the skeleton. The calcium in these cases is mentioned twice, once where it was 9.8 milligrams and once a reading of 12.6 milligrams. The calcium output, however, was greatly increased, being reported once six times normal in twenty-four hours urine, that is, 840 milligrams *vs.* a normal of 186 milligrams. A simultaneous increase of cholesterol to 250 milligrams *vs.* 180 milligrams normal seems to be characteristic only for the basophile adenoma and not for parathyroidism.

From these statistics of findings of osteoporosis, scoliosis, spontaneous fractures and loss of height it is evident that the group may resemble that of parathyroidism. The distinguishing features, however, will always pro-

tect against any mistakes in diagnosis. The general symptom complex of the basophile adenoma includes such outstanding symptoms as the hypertension, frequently a hypercythæmia of six million reds and more, an acrocyanosis, the most peculiar (buffalo type of) adiposity limited to neck, face and trunk, not affecting the extremities, the peculiar pigmented striæ on the abdomen will always be outstanding. Again, in this chapter of basophile adenomas the autopsies have frequently shown secondary hyperplasia and even adenomas of the parathyroids and other endocrine glands, these possibly being the producers of the skeletal symptoms and the increased calcium excretion.

(5) *Skeletal Changes Following Early Surgical Menopause* (Loss of Ovarian Function)—In the basophile type of adenomas an outstanding symptom is amenorrhœa occurring at twenty or thirty years of age, the favorite time for the starting of basophilism; but this amenorrhœa without any doubt is caused by interference with the sexual function of the pituitary. Another connection between early surgical menopause and decalcification of the skeleton, we could even say with real parathyroid changes of the skeleton, seems to be evident from our material. Of eighteen women with different types of parathyroidism, proven by X-ray, chemical changes and symptomatology, six had early menopause. For instance:

CASE I.—Mrs. J. C. M., at twenty-five years, had an extensive myomectomy after which she flowed only very scantily for two years more. She had broken her hip at seventeen years; had no trouble, it healed well. After the myomectomy new pain ensued in the hip and X-ray showed a large process of osteitis fibrosa cystica taking in the whole upper part of the left femur and the whole left ilium and acetabulum. Blood calcium was over twelve milligrams. Removal of a parathyroid adenoma gave complete relief.

CASE II.—Mrs. H. G., on account of pelvic inflammatory disease, had both tubes, right ovary and most of the left ovary removed. This was at the age of thirty-two years. She menstruated very scantily up to the age of thirty-six, then ceased entirely. She had severe backaches, X-ray showed decalcified spine with wedging of the vertebral bodies, exostosis of the vertebræ and a blood calcium of 11.2 to 12 milligrams. A small parathyroid adenoma was removed with great relief.

CASE III.—Miss J. A. B. had a radical pelvic operation performed for a pelvic inflammatory at the age of thirty-four years with cessation of menses. At the age of forty-four years frequent falls and several fractures occurred, severe hypotonia of the muscles ensued, the legs would not carry this heavy woman of two hundred pounds any longer. The serum calcium was 12.8 milligrams. The röntgenogram of her spine showed compressed vertebræ and large metastatic calcium deposits in the intervertebral discs. Parathyroidectomy gave complete relief.

CASE IV.—Mrs. M. R. R. had, at thirty years, a pelvic operation for inflammatory disease. Menstruation practically ceased after this. At forty-eight years she became very heavy. At forty-five years she had backache, at forty-eight she had a vertebral fracture from a slight cause. This led to thorough examination and several compression fractures of the vertebræ, osteitis fibrosa cystica of the skull, and so on, were found. A parathyroid adenoma was removed with relief of the pain and her symptoms. (Fig. 5.)

We could repeat practically the same history several times more if we included our newer cases. This coincidence is, therefore, so frequent in

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our female patients with parathyroidism that attention should be called to it. While they all had hyperplastic or adenomatous parathyroids, it seems from their records that in nearly every one of them the early post-operative menopause started the symptoms of parathyroidism.

(6) *Suprarenal Gland, Pancreas and Polyglandular Syndromes.*—Wilder²⁰ published four cases of "polyglandular dyscrasias." The first one is a case which, since

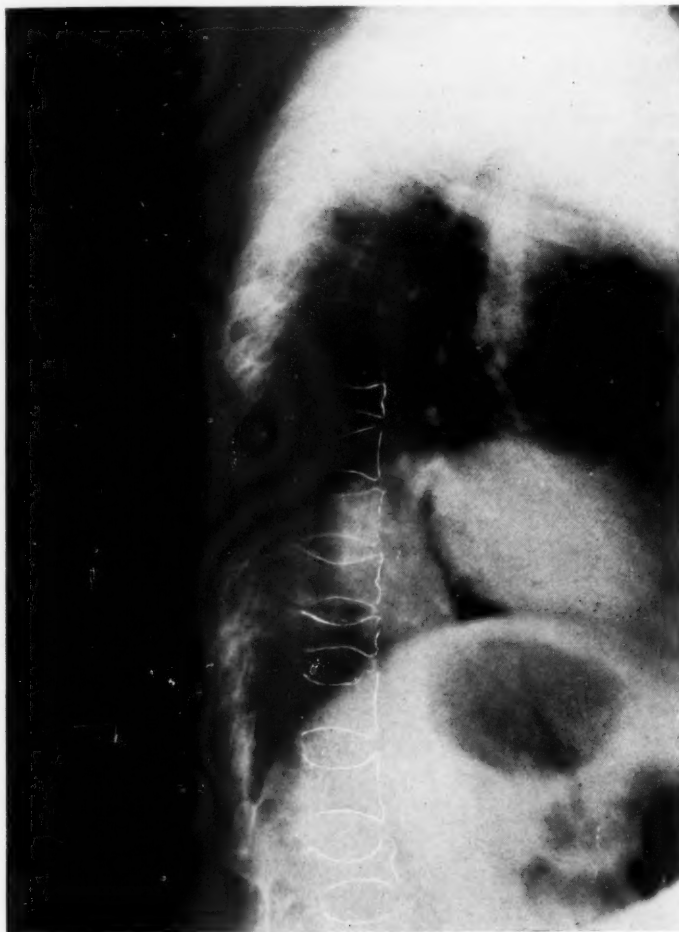


FIG. 5.—*Parathyroidism.* First symptoms appeared after early surgical menopause. Note compression of several vertebral bodies (retouched), decalcification and formation of nucleus pulposus. Serum calcium thirteen milligrams. Hypotonia. Great improvement following parathyroidectomy.

Cushing's⁷ communication on basophile adenomas, should be placed under the heading of basophilism, "bearded ladies," and so forth. Besides the hirsutism, the pigmented striæ on the abdomen, the adiposity and hypertension, she had an osteoporosis of the skull and spine and multiple pathological fractures of the lower ribs with extensive callus formation. She was operated upon for suprarenal tumor but only a microscopical adenoma was found in the left suprarenal. She was treated after with Röntgen-ray for the pituitary tumor.

His second case was considered an adrenal tumor. She had the same symptoms of

adiposity around the trunk, high blood-pressure and muscular weakness. The X-ray showed osteoporosis of the spinal column with compression fracture of the eleventh thoracic vertebra, osteoporosis of the pelvis, femurs and skull. There was increased cholesterol in the blood. Both suprarenals were exposed for tumors but none found.

CASE V.—(Wilder²⁰.) Again a woman thirty years old with hirsutism, weakness, amenorrhœa, extreme muscular weakness nearly resembling muscular paralysis of the legs without neurological symptoms pointing to any local or systemic neurological affection. There was also glycosuria. At death a cancer of the *pancreas* was found; no tumor of the suprarenal gland, however. The röntgenological study showed slight osteoporosis of the spinal column, ribs, pelvis and femurs and calcified mesenteric glands.

A sixth case (Wilder²⁰) concerns a woman thirty-four years old with amenorrhœa at thirty-two years, who was stout, had facial hirsutism, was round-shouldered, failed in health, had weakness of the legs, trunk obesity and hypertension. Röntgenogram showed osteoporosis of thoracic and lumbar vertebræ with compression of the sixth thoracic vertebra. There was a slightly toxic adenomatous goitre removed previously, great weakness of legs. An autopsy on this woman showed normal pituitary gland, both *suprarenals* enlarged and hyperplastic, combined weight forty-nine grams, a thymus tumor about five centimetres in diameter, an *abscess in the pancreas*, a multiple colloid adenomatous tumor, friable ribs breaking between the fingers.

Dr. F. W. Hartman,²¹ of the Ford Hospital, mentioned, in discussing a paper on parathyroidism before a local society, an autopsy showing extensive osteomalacia of the skeleton with a progressed sclerosis of the pancreas. He kindly allowed me to use the following notes on the case: "Thirty-five-year-old man, first seen in 1921, in the following two years developed a picture resembling Paget's disease, lost two inches in height, legs became curved, calcium ranged from 9 to 16.5 milligrams, phosphorous two to three milligrams. Biopsy of bones in 1924 showed osteitis fibrosa cystica. Fracture of right femur in 1926 while sneezing. He died in 1927. The findings at the very minutely carried out autopsy were: Skeleton very soft, extensive osteitis fibrosa cystica, irregular cyst formations around the fracture in the femur; thyroid nothing abnormal; no abnormality in a piece of parathyroid attached to the thyroid; pancreas shows a very unusual picture, smaller than normal, very firm, pale, scarred appearance, cutting with a rasping sound and gritty resistance felt throughout, the lobular markings have disappeared, irregular cystic dilatation in the otherwise fibrous organ. Microscopically, chronic fibrous pancreatitis with some intact islets. Chronic nephritis with retention cysts; in the right kidney a minute adenoma, seven by five millimeters (microscopically benign). Thymus, nothing abnormal. Adrenals, 'nothing worthy of special note.' Pituitary, anterior and posterior parts usual cellular appearance; in the intermedia part numerous acinar structures with colloid material. Incidentally, some encysted trichinæ in muscles." The outstanding finding in this case is certainly the chronic fibrous pancreatitis with extensive general osteitis fibrosa cystica.

It is evident from these descriptions that in the case of pituitary basophilism (less in acromegaly), in pathology of the pancreas (a cancer in Wilder's third case, an abscess in his fourth case), in adrenal tumors similar symptoms of polyglandular upsets seem to be frequent.

(7) *Xanthomatosis* (Schüller¹⁸-Christian⁵ Syndrome).—The peculiar complex of symptoms usually called Schüller-Christian disease or disturbance of the lipid metabolism, which was described by Hand twenty years before Schüller,¹⁸ has not been classified generally as an endocrine disturbance; still, Schüller was inclined to consider it a "dyspituitarism." On account of the prevalence of osseous symptoms it deserves to be mentioned here. Schüller called attention to sharply defined "geographical defects"

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in the skull. Christian⁵ outlined the symptom complex as consisting of defects of the membranous bones, diabetes insipidus and exophthalmos. Rowland,¹⁷ of Detroit, collected much material with three cases of his own and thought that the osseous defects, the dyspituitarism and exophthalmos had one common feature, that is, the formation of xanthomatous tissue. Xanthomatosis is a local manifestation of this disease and brings it also in contact with Gaucher and Niemann-Pick disease. In this unit, for some reason or another, most likely endocrine, an overproduction of lipoid substance occurs, a hyperlipæmia; this fat is deposited and stored mainly in the reticulo-endothelial system; the etiological factor is not located in this system. Anyway, the deposit of xanthomatous tissue causes exophthalmos through great deposits back of the eyeball and in the dura. It seems that such deposits pos-

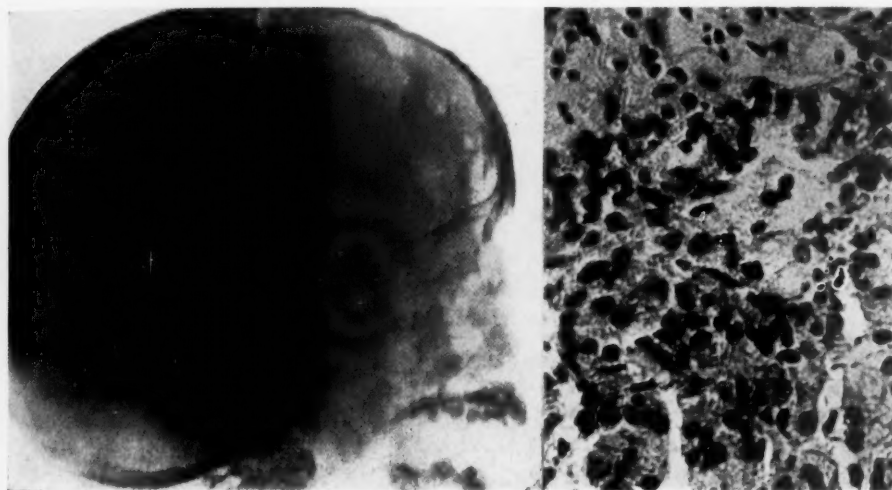


FIG. 6.—Xanthomatosis (lipoid dystrophy). (1) Bony defects in the skull ("geographical" in shape), such defects being practically limited to the membranous bones. (2) Defects are caused by lipid (foam) cells and foreign-body giant cells arising from dural plaques. (Through kindness of Dr. R. S. Rowland, Detroit, Mich.)

terior to the pituitary in the region of the hypothalamus and the pineal body may have a good deal to do with the production of the pituitary symptoms, especially the diabetes insipidus. The skull defects in this special group are large, measuring up to five and six centimetres and more in diameter, irregular-like geographical maps. They are seemingly produced simply by the pressure of the xanthomatous tissue growing on the dura (just like an aneurysm would erode the bone) or the substitution of osseous by lipoid tissue.

The calcium and phosphorus are not changed. Cholesterol, however, and fatty acids are very much increased in the blood-serum. Cholesterol seems to be the fat most deposited in the Schüller-Christian disease, whereas in Niemann-Pick disease and in Gaucher's splenomegaly lecithin-like fats prevail.

Figure 6 shows how these defects, by their size and irregularity and by

being confined to membranous bones, differ from the small granular or larger cyst-like defects in parathyroidism; also the complicating diabetes insipidus, fibrosis of the lungs following xanthomatosis of the lungs, all these symptoms obviously make the differentiation between Schüller-Christian syndrome and parathyroidism very easy. The treatment of the group, since we do not know for certain the actual cause, is symptomatic and Rowland¹⁷ reports results in early cases by giving a diet to prevent the hyperlipæmia.

(8) *Decalcification in Renal Rickets, in Splenomegaly with Hæmolytic Icterus and in Complete Absence of Bile from the Intestines.*—This chapter is mentioned incidentally for its similarity in findings without any attempt at present to refer it to an endocrine cause.

Renal rickets is characterized by nephritis and most severe osteomalacia. In a case observed the bones could be cut at autopsy with an ordinary knife just as in a very progressed case of parathyroidal osteomalacia. At the same time the kidneys were entirely atrophied, small, about one-sixth the normal size. There was also a large parathyroidal adenoma. This same observation has been made by different observers, that is, the combination of the peculiar renal atrophy with parathyroid tumor. An outstanding clinical symptom in renal pathology is very high serum phosphorus going up to five milligrams and even more. This seems to be a symptom singular to this affection. The bones can hardly be distinguished from those in progressed parathyroidal osteitis fibrosa cystica and the relatively frequently found parathyroid tumor still more suggests some relationship. It suggests itself that the affection of renal rickets existing early in life may be due to a shrinking of the kidney following hypercalcæmia as it is known in the usual case of parathyroidism. Still, the pathological findings in these atrophied kidneys seem to speak more for a primary nephritic process or a congenital deficiency of the kidney leading secondarily to a high phosphatæmia and the osteomalacic changes.

Still weaker in reason for being classified with endocrine disturbances is the entity of *anæmia* in children with *splenomegaly* and peculiar changes in the bones. This is a syndrome now described quite frequently under different names, occurring early in life, during the first two years, characterized by a hæmolytic anæmia, possibly due to a defect in the hæmopoietic system, the blood-picture being characterized by a great number of immature forms, leucocytes and changes in the bones. Icterus seems to be prevalent also in this group. The peculiar bone changes as expressed suggest that for differential diagnostic study the affection deserves to be mentioned here.

A good deal of experimental work has been done besides a few clinical observations in *complete bile fistulas* showing that absence of bile from the intestinal tract leads to osteoporosis, softening of bones and spontaneous fractures. (Pavlov, Wisner and Whipple, Emerson, J. D. Greaves and Carl L. A. Schmidt.⁹) It is most interesting that even the smallest amount of bile in the intestinal tract under such conditions will prevent these osteomalacic processes. Therefore, it seems the suggestion may be correct that in the absence of bile vitamine D is not absorbed; otherwise, it is hard to understand why the presence of a very small amount of bile in the intestine would

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prevent the osteomalacias. Animal experiments have shown that in dogs where a bile fistula was established, usually by connecting the gall-bladder with the pelvis of a kidney (cholecystonephrostomy), on a known calcium intake a negative calcium and phosphorus balance was present; the administration of viosterol would make this balance again positive. The similarity between the non-absorption of vitamine D in parathyroidism and also in bile fistulas warrants mentioning this osteomalacia even if at first it is seemingly just an avitaminosis.

Conclusions.—Classical osseous changes in endocrine disease are caused by parathyroidism, but also in thyroidism we find decalcification, immense new formations in bones are encountered in acromegaly, whereas in the basophile pituitary tumor changes similar to those in parathyroidism have now been frequently encountered. The osseous changes with pathology of the pancreatic islets, the suprarenal bodies have been described; they can be best understood by the simultaneous occurrence of polyglandular adenomas or hyperplasias. The skeletal changes in complete bile fistulas may be only an avitaminosis, at least no endocrine cause is known so far. The lipid changes leading to large defects in the membranous bones may be due to some endocrine changes caused by invasion of the region posterior to the hypophysis by xanthomatous tissue. The etiology of the osseous pathology in the syndrome with leukemic splenomegaly is not understood so far.

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EMERGENCY COMPLICATIONS OCCURRING AFTER OPERATIONS ON THE STOMACH AND DUODENUM AND THEIR TREATMENT

By DONALD C. BALFOUR, M.D.

OF ROCHESTER, MINN.

COMPLICATIONS which may occur after operations on lesions of the stomach and duodenum and which may give rise to the consideration or necessity for secondary operation on the stomach or duodenum are rare. For this rarity surgeons are indebted to the pioneers in this field of surgery who encountered these complications frequently, and by continually modifying methods of treatment lowered their incidence to a minimum. In accomplishing this, American surgeons played a conspicuous part.

However, in spite of adopting the well-established principles, and carrying them out with meticulous care, complications do occasionally arise which may be directly responsible for death, which may require secondary operation or which may present a most difficult problem as to the necessity of further operation. The possibility of serious complications is always present in this field of surgery, not only because of the nature of the lesions for which the operation has been done and the condition of the patient, but because it is so often found that extensive reconstructive procedures are required to deal adequately with the existing disease. The very fact that with such a combination of factors contributing to the occurrence of complications they rarely do occur makes the problems of secondary emergency surgical conditions, when they are encountered, both intricate and perplexing.

From a surgical standpoint mechanical dysfunction is the major complication which may arise during convalescence following operations on the stomach and duodenum. It is true that the possibility of dysfunction is always present, since all operations for either benign or malignant lesions bring about a change in the mechanics of digestion of greater or lesser degree. It is true also that the nearer any operation approaches success in this respect, the more remote is the danger of motor dysfunction occurring either in the immediate or late convalescence of the patient. In the treatment of ulcer, the operation, whether it is reconstruction of the pyloric outlet, gastroenterostomy or one of the various types of resection must not impair the emptying of the stomach but it must also enable it to be more easily emptied if the best possible results are to be secured in respect to relief of symptoms and to protection against recurrence of ulceration. If operation for ulcer fails to accomplish this improvement in the emptying power, the problem of a secondary operation may be introduced, either for an emergency mechanical defect during the immediate convalescence of the patient or later, for recurrence of ulceration or because of chronic malfunction. Although such

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possibilities may be said to exist always, it can also be said that if the type of operation for ulcer has been well chosen and the details of the operation satisfactorily carried out, no difficulty in gastro-intestinal mechanics occurs.

When evidences of dysfunction of the upper part of the gastro-intestinal tract appear following operation for a lesion of the stomach or duodenum, the significance of the symptoms and the indications for treatment will depend, to a considerable extent, on the type of primary operation which has been performed. In reconstruction operations at the outlet of the stomach, whether simple plastic procedures on the anterior wall of the duodenum and pylorus, or partial duodenectomy, or gastric resection in continuity with end-to-end approximation of the stomach to the duodenum, any difficulty in the proper emptying of the stomach is not of serious import if the surgeon has felt satisfied at the completion of the operation that an adequate lumen had been created between stomach and duodenum. In such event any retained gastric contents can be aspirated by continuous or intermittent suction, and body fluids can be maintained by intravenous injections of sodium chloride and glucose until the pyloric outlet functions well. Delayed emptying in such cases is probably due to œdema about the reconstructed area, and as this œdema subsides, function is restored. If, on the other hand, the surgeon has been doubtful as to the capacity of the new outlet to function as well as desired, one of two plans can be followed. The first plan is that of performing jejunostomy before accepting the necessity of gastroenterostomy to overcome any impaired motility. Such a plan is preferable in cases in which a primary operation on the pyloric outlet had been chosen because it had seemed more desirable than any other for the future well-being of the patient.

The second plan is that of performing gastroenterostomy or gastric resection as a secondary procedure as soon as it is evident that gastric retention persists. This plan should be followed when the surgeon had felt at the time of the primary operation that the outlet made was not altogether satisfactory, and when there had not been any unusual reason for the type of operation that had been performed. To determine whether the retention is sufficient to justify a secondary operation is occasionally difficult, but if it is shown that most of the fluid taken by mouth is recovered by tube, and no improvement in the situation occurs, it is best to reoperate. If supplementary gastroenterostomy is done, the surgical treatment of the ulcer has then been converted into a procedure which experience has established as one of the most effective methods of dealing with peptic ulcer. It is well, therefore, to keep this important fact in mind when debating the advisability of adding gastroenterostomy to excision and reconstruction of the pyloric outlet, either at the primary operation, or as a secondary procedure. As I have stated, it is only when circumstances dictated against gastroenterostomy as a primary procedure that it should be avoided as a secondary procedure; if the patient is young, gastric acids are high, and motility is unimpaired, gastroenterostomy is not ordinarily indicated as a primary procedure.

Gastro-intestinal obstruction following gastric resection by the Billroth II method or one of its modifications is seen rarely. The gastrojejunal anastomosis in these cases permits much greater leeway in regard to length of the proximal loop than is advisable in performing gastroenterostomy without resection. There are, however, four possibilities by which obstruction following Billroth II resection or one of its modifications may occur. The first results from retraction of the anastomosis into the lesser peritoneal cavity. There is, however, little danger of this, if the mesocolon is carefully sutured to the stomach. Although examples of the accident have been reported in the literature and the complication has been encountered in our clinic, yet retraction of such an anastomosis is not only rare but if it should occur it is probably not as likely to give rise to obstruction as was formerly considered. Support for this belief is in the fact that a continental surgeon of wide experience in this field of surgery does not hesitate to allow the anastomosis to remain in the lesser peritoneal cavity if there is marked difficulty in bringing down the gastrojejunal anastomosis below the level of the mesocolon after a resection.

A second cause of obstruction in this type of operation is adhesion or deformity of the distal loop of the bowel. In one case, I found it necessary to reoperate for severe gastric retention which was caused by a loop of jejunum becoming adherent to the anterior abdominal wall; the gastro-intestinal function was promptly restored following the mobilization of the loop.

A third possible cause of inadequate drainage of the stomach following Billroth II resection is the failure to make an entero-anastomosis between the two loops of jejunum when the gastro-intestinal anastomosis has been made anterior to the colon and consequently on a long proximal loop. There may be sufficient post-operative retention within this loop so that entero-anastomosis may become advisable as a secondary procedure, and recognizing this as a possibility it is good practice to make the entero-anastomosis at the time the primary operation is performed. It is important in this respect to remark that this anterior type of resection is largely confined to extensive operations for carcinoma, so that any question as to the advisability of entero-anastomosis in connection with operation for ulcer rarely arises.

The fourth cause of persistent gastric retention following resections of the Billroth II type is atony. I have encountered only one of this type of case in which a mechanical defect was not discovered, either at second operation or at necropsy, to explain the almost complete inability of the stomach to empty itself after extensive resection for carcinoma, with anterior gastro-jejunostomy and entero-anastomosis. The only clue which offered a possible explanation was that the patient, who was aged more than seventy years, had previously required hospitalization on a number of occasions for severe, protracted and unexplained vomiting.

The method of correction of gastro-intestinal obstruction after the Billroth II operation is obvious under the circumstances of the first three causes.

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Clear evidence that the stomach is unable to pass an adequate amount of material on into the jejunum justifies a second operation. The important feature of such a procedure is that after mechanical difficulties have been corrected, a catheter should be left in the upper part of the jejunum to compensate for the nourishment the patient has already lost. The only procedures possible when the obstruction is due primarily to atony are continuous aspiration of gastric contents and maintenance of fluids and nourishment by jejunal feedings.

From a surgical standpoint, the most serious of all mechanical complications is obstruction of the upper part of the jejunum, proximal to a gastro-jejunal anastomosis used in connection with gastric resection. Real constriction of the lumen of the jejunum at such a site can occur only in cases in which it has been necessary to make some repair of the jejunum, as in jejunal ulcer. The symptoms of such obstruction, resulting as it does in retaining within the duodenum all secretions, are those of increasing shock, severe lumbar pain and toxæmia; death occurs if the obstruction persists. I have observed one case in which this occurred; the obstruction was due to my invaginating into the lumen of the jejunum too much of the wall of the bowel while repairing an extensive defect following gastric resection for jejunal ulcer. The obstruction was a gradual onset, so that the closed duodenal stump, which had been inverted as part of the gastric resection, remained intact. At necropsy the duodenum was about twenty centimeters in diameter, was filled with foul, bloody fluid, and its walls were gangrenous. In any necessary jejunal repair, therefore, it is particularly important when the proximal end of the duodenum is closed, that any doubt as to the adequacy of the lumen of the jejunum be removed by performing enteroenterostomy so as to carry the alimentary content around the site of repair.

The greatest problem in connection with obstruction of the upper part of the gastro-intestinal tract concerns the mechanical difficulties following gastro-enterostomy. It should first be emphasized that the performance of gastro-enterostomy has been so carefully developed that when it is done on proper indications and according to sound principles of technic, serious mechanical difficulties are extremely rare.

The rarity of a poorly functioning anastomosis, however, does not minimize its importance both from the standpoint of the best treatment of the complication and from the standpoint of providing an explanation for such malfunction. It is true that gastric retention in some degree, during the convalescence of patients on whom posterior or anterior gastroenterostomy has been performed, occurs at least often enough to give added significance to this problem. The occasional occurrence of marked retention between about the tenth and fourteenth days following operation is difficult to explain. Sherren and Walton attributed the obstruction in some cases to a constricting opening in the mesocolon. This retention is not preceded by any evidence of mechanical difficulties, and is not repeated after the stomach is thoroughly lavaged. In some cases, indiscretion in the amount of fluid and nourishment

taken unquestionably has been a factor and there is the possibility that at the time of the difficulty the most marked readjustment of gastro-intestinal mechanics is taking place. It is vitally important in this type of case not to permit gastric contents to accumulate again. I have seen the unfortunate results of this in the necessity of a secondary operation because of the disturbance in neuromuscular mechanism, the result of chronic dilatation. On the other hand, careful avoidance of the repetition of such retention after the first week is almost certain to obviate the necessity of any further operation. The obstruction which is most disturbing is manifested soon after operation in the patient's tendency to regurgitate gastric contents and his inability to take fluid nourishment normally. Again, the treatment is of the greatest importance, since, unless there has been gross error in the indications for and the technic of the operation, careful post-operative care in respect to withholding nourishment and keeping the stomach emptied probably will be followed by adequate function. In the rare event of it becoming evident that fluids are not leaving the stomach in sufficient amounts and there is no improvement in this situation, the question of reoperation must be considered.

There are two general principles under which further surgical procedures should be carried out. The first concerns those cases in which it is either known or it is learned at the time of the secondary operation that some defect in the technic of the operation has been responsible for the obstruction. This may have been due either to an error at the time of the operation, such as making too long or too short a proximal loop of jejunum, insecurely fixing an anastomosis below the level of the mesocolon, or making anastomosis at an improper site.

If the cause of persistent retention and regurgitation of bile is a proximal loop of too great length, the difficulty can be promptly corrected by anastomosis between proximal and distal segments of the jejunum. This procedure is of real value only in such cases; it will fail to relieve the obstruction if it is due to any other cause. An entirely different surgical problem is presented in cases in which the obstruction is due to edema and inflammatory exudate about the anastomosis, in which the anastomosis is too small, in which it is improperly placed, in which the proximal loop is short, or in which there is intussusception of the structures involved in the gastroenterostomy or intussusception of the distal part of the jejunum into the stomach. I believe that in all such cases the best procedure is to take down the gastroenterostomy by disconnecting the jejunum from the stomach, unless the deformity can be definitely corrected and its recurrence prevented, as in the rare possibility of obstruction from jejunal intussusception, as recently reported by Bettman. Disconnecting the gastroenterostomy may appear to be formidable, especially if undertaken after the second week, for by this time inflammatory exudate has become more firm and mobilization of the anastomosis is not as readily accomplished as in the first ten days after operation. If, however, it is remembered that the anastomosis was made, in all probability, with both the jejunum and the wall of the stomach well out-

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side the abdominal incision, it will be realized that it should be possible again to mobilize the anastomosis so that it is reasonably accessible. The patient's condition usually will not permit an attempt of any other surgical procedure to deal with the condition which it was the purpose of the gastroenterostomy to correct.

Methods other than taking down the gastroenterostomy are occasionally useful and will be successful if the obstruction is caused by inflammatory oedema. If this is the cause a catheter in the distal part of the jejunum, for feeding, and the maintenance of an empty stomach by aspirating with a tube, will carry the patient along until the obstructive oedema has subsided. Walters suggested and described the use of two catheters in the jejunum, one extending up into the stomach from which the gastric secretions could be collected so they could be reintroduced into the feeding catheter. When the obstruction is due to a deformity of the distal loop either from kinking or adhesions, the difficulty can probably be corrected, and recurrence prevented by the introduction of a tube through the anterior wall of the stomach for a distance of about thirty centimetres or more into the distal part of the jejunum. This plan was suggested to me several years ago by W. J. Mayo; it serves a two-fold purpose, that of permitting the administration of nourishment, and establishing a course for fluids to leave the stomach. I have used this plan in two cases. Relief was prompt, and in both cases the tube was removed within a week, with prompt healing of the opening in the stomach.

To select the most satisfactory time to perform the secondary operation is most difficult. Reoperation during the first week following gastroenterostomy is not associated with much technical difficulty and yet it is seldom necessary to reoperate so early, since sufficient time has not elapsed to determine whether it is necessary. Therefore, unless the cause of the obstruction indicates that immediate interference is necessary, operation is usually undertaken during the latter part of the second or in the third week. At this time the technical difficulties of any major procedure are markedly increased since the persisting obstruction and the trauma incident to it have added greatly to the local inflammation. The operation should be further postponed unless it is clearly inadvisable to do so because of the probable subsidence of these inflammatory products and the possibility that the obstruction will be relieved gradually. In other cases postponement may improve the condition although not completely relieve it, and the patient will continue to suffer from intermittent obstruction. Surgical relief during this chronic stage is infinitely easier to accomplish, and it is more effective than during the acute obstructive stage. The opportunities and advantages of studying gastrointestinal mechanics in a chronic condition rather than during an acute upset are, of course, apparent. The place of Röntgen-rays in determining the cause of mechanical difficulties in a gastroenterostomy has not, as yet, been worked out satisfactorily. The correlation of apparent deviations from normal as shown by röntgenograms, and of disturbed function as observed clinically, is difficult, just as is true in other parts of the body. Unnecessary

apprehension and occasionally operation may be the result of too great reliance on the behavior of a gastro-intestinal anastomosis under the fluoroscopic screen.

The most accurate indication of the seriousness of any obstruction in the upper part of the gastro-intestinal tract is the resultant disturbance of the chemistry of the blood. Such disturbance, in the early stage at least, can be promptly corrected by adequate intravenous medication, but one should not be deceived by such control into believing that the obstruction is relieved since experience has shown that the obstruction can be complete and yet its toxic effects still be combatted by intravenous medication. If, however, obstruction continues, return to normal of the chemistry of the blood is only temporary, and any unfavorable change in chemistry of the blood, when every means is being used to prevent it, is usually an indication that surgical obstruction exists.

These secondary operations for mechanical complications are usually so urgent that there is seldom justification for considering any substitute for gastroenterostomy if it has been decided to disconnect the anastomosis. Certainly in cases in which there has been little if any obstruction associated with the duodenal ulcer, there would be no urgent need of any operation for the ulcer after the gastroenterostomy has been taken down. If, however, the pylorus has been markedly narrowed by a contracting type of ulcer, the taking down of a gastroenterostomy is a much more serious procedure from the standpoint of the treatment of the disease. In such cases it is desirable after taking down the posterior gastroenterostomy to circumvent the pylorus either by a new gastroenterostomy made anteriorly or by a gastroduodenostomy with or without excision of the contracted area. The double operation can be done, of course, only if the patient is in fairly good condition and if both operations can be done expeditiously.

Adding a second gastroenterostomy when the first one has become obstructed is a makeshift, and it is only a question of time before further operative procedures will have to be carried out. In the cases we have seen in the clinic, in which both posterior and anterior gastroenterostomy had been done previously, the history usually has been much the same, namely, primary posterior gastroenterostomy has been done, uncontrollable gastric retention has developed, and anterior gastroenterostomy has been made. If the patient survives this secondary operation, the relief of the obstruction is usually only partial, and chronic or recurrent vomiting is the sequel. In some cases this is not severe and nutrition is lost slowly. On the other hand, the patient may lose ground rapidly and the surgeon is forced into an operation at a time when local conditions are not suitable for the extensive procedures which are inevitable. In the former group of cases, that is, those which have become more or less chronic and in which the primary gastroenterostomy was done for marked obstruction at the pylorus, I have found the best plan after taking down both gastroenterostomies (which, of course, must be done in any event) is to repair the resulting jejunal defects, then resect the stomach

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to a point above the site of the highest gastroenterostomy, and reestablish gastro-intestinal continuity by anastomosing the end of the stomach, after it has been partly closed, to the second portion of the duodenum. I have found this to be more easily accomplished than might be expected because the state of chronic obstruction has stretched the stomach and the first and second portions of the duodenum.

This consideration of the obstructive complications which may require secondary emergency operations following operations for lesions of the stomach and duodenum may give a false impression as to the incidence of such complications, for in the aggregate, when the primary operation is clearly indicated and the principles of surgery of this field are really followed, the complications are exceedingly rare.

Small as the incidence of the complications named, it is nevertheless true that when they do occur they are most serious and whether or not they require secondary operation they always confront the conscientious surgeon with the question of whether that particular complication might have been avoided. It cannot be expected that such complications can be completely prevented, but meticulous care in the selection of the type of operation, and in its performance by the surgeon with adequate experience, will hold such complications to a minimum.

CLOSURE OF THE ABDOMEN WITH THROUGH-AND-THROUGH SILVER WIRE SUTURES IN CASES OF ACUTE ABDOMINAL EMERGENCIES

BY MONT R. REID, M.D., AND (BY INVITATION) M. M. ZINNINGER, M.D.
AND PAUL MERRELL, M.D.

OF CINCINNATI, OHIO

FROM THE SURGICAL DEPARTMENT OF THE UNIVERSITY OF CINCINNATI AND OF THE CINCINNATI GENERAL HOSPITAL

ALTHOUGH silver wire has long been used as a suture material in surgery, there are few published reports regarding the various methods of its application. The impression is gained that its use in the past has been more or less sporadic, and that at the present time it has been practically abandoned. For more than ten years we have been using it extensively at the Cincinnati General Hospital in the closure of abdominal wounds in certain selected types of cases, and have found a constantly widening field of usefulness for it.

In the method to which we refer, silver wire is used in a series of interrupted sutures through the entire thickness of the abdominal wall—skin, fat, fascia, muscle and peritoneum—no other sutures being used except, occasionally, a few in the skin to keep the edges of the wound from everting. It is not quite clear to whom the credit belongs for first using this method, although in Professor W. S. Halsted's Clinic in Baltimore a similar method was frequently used for closing wounds which had broken open following operation. It is known that Dr. C. L. Bonifield, of Cincinnati, used silver wire for closure of the abdomen in certain cases. Only published report we have been able to find is one by Shipley,³ in 1925, which deals only with the secondary closure of ruptured abdominal incisions. Höyer¹ also reported use of an aluminum-bronze wire in a somewhat similar manner in 1927, and Minin and Akush² report the use of fine silver wire in continuous suture in layers.

The method as we use it is as follows: Ten- to twelve-inch lengths of virgin silver wire,* No. 20 gauge, are threaded on large, curved, cutting edge needles such as are ordinarily used for inserting "traction" or "tension" sutures. The short end is folded back over the eye of the needle and crushed flat with a heavy forceps so the wire will more easily go through the hole made by the needle. A clamp is fastened on the free end as is done with silkworm-gut "stay" or "tension" sutures. A series of clamps is placed on the edge of the peritoneum. All the silver-wire sutures are then placed but not tied. For each suture the needle is started about one or one and a half inches from the edge of the incision and carried through the entire thickness of the abdominal wall, including the peritoneum. The suture is continued by bringing it out at a corresponding place on the opposite side of the incision. It is important that no kinks be allowed to get in the wire during this step as they are exceedingly difficult to get out smoothly. The needle is unthreaded and a clamp placed on the free end of the wire. A series of such sutures is placed about one and one-quarter to one and one-half inches apart, five to eight being used to close the average incision. After all are placed, the clamps on the

* The most pliable wire should be used. It is our custom to buy it in one-ounce lots and rolled on a spool.

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peritoneum are removed and the incision closed by pulling up and twisting each wire individually. Beginning at one end of the incision, the operator pulls up on the clamps at opposite ends of one suture. The first assistant puts a finger inside the abdomen and reports when the wire is pulled sufficiently tight to bring the peritoneal edges in firm contact. The wire is then twisted six to eight times just above one of the openings through which it emerges from the skin—not over the line of incision. Each wire is pulled up in succession and twisted. (Figs. 1, 2, 3 and 4.) It is extremely important that the desired tension be obtained before the twisting is started because the twisting is for the purpose of holding only and will not tighten the suture nor remove any slack in it.

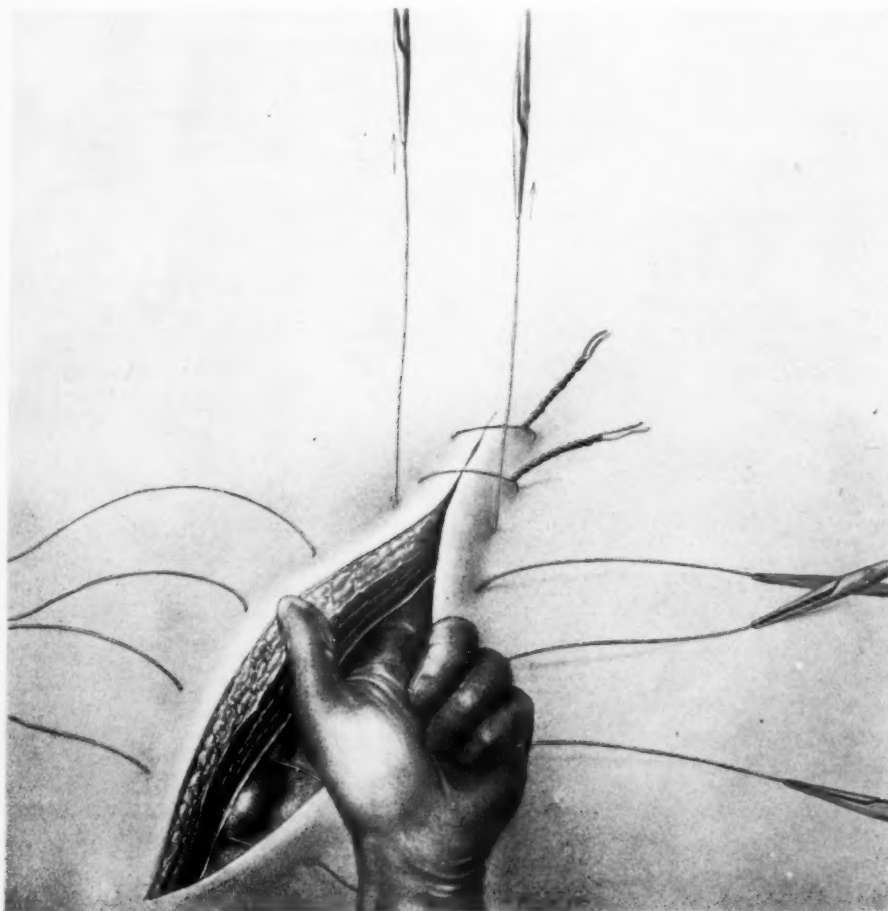


FIG. 1.—Method employed in pulling up and twisting the wire sutures. The finger in the abdomen protects the intestines, and lets one know when the suture is pulled sufficiently tight.

After all the sutures are fixed in this way, one or two silk stitches may, if necessary, be placed in the skin between each two wires to prevent eversion or inversion of the skin edges. The wires are cut rather long, as they are easier to manipulate in the dressings if an inch or more of straight wire is free beyond the twisted part. No rubber tubing or other material is placed about the wires where they cross the incision or between the wires and the skin. There is usually some cutting of the skin under the wires before they are removed, but this has never constituted a serious complication of wound healing. Various modifications have been tried in an effort to prevent this cutting of the skin, but the method just described has been more satisfactory than any of the modifications.

This entire procedure can be carried out in only a fraction of the time necessary for a formal closure of the incision in layers.

It is also possible by this method to close a wound which is under considerable tension or one in which the peritoneum fails to hold sutures but tears with each attempt to pull it together. In addition, this closure is extremely valuable in all cases in which there is likely to be infection, as it gives a very secure closure which is not affected by infection or even by extensive slough of the fascia. Indeed, it was this property which first led to the adoption of this method in closing the abdomen after such acute traumatic conditions as gunshot wounds and stab wounds.

Prior to the use of this method, there occurred four instances of post-operative rupture of the abdominal wound in cases of gunshot wound of the abdomen in the one year 1922 alone. Since its adoption there has been no

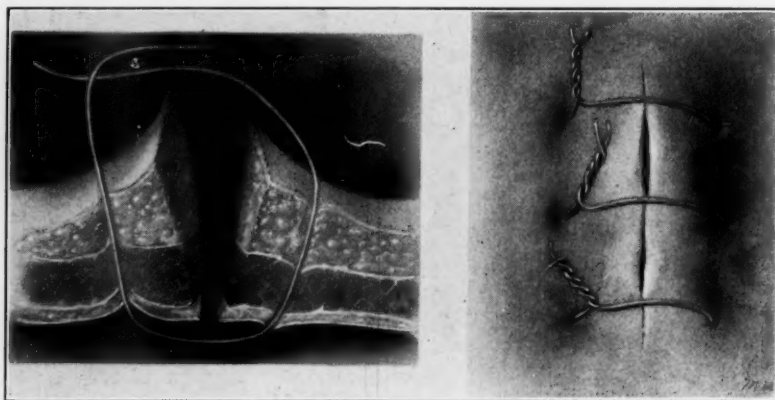


FIG. 2.—Diagram showing position of the wire and illustration of the wound after closure.

case of rupture of an incision closed by silver wire during ten years. There have been two instances only in which a loop of bowel or bit of omentum protruded between two wire sutures due to the fact that they were placed too far apart or were not sufficiently tight.

We have been able to find and review the records of 334 patients in which this type of closure was used. Since these cases were operated upon for widely varied conditions, and were not filed together, nor was any cross index available as to the type of abdominal closure, we have undoubtedly overlooked many other instances in which silver-wire closure was done. In a few of the earlier cases a continuous suture of catgut was first placed in the peritoneum, but this has been found to be unnecessary and is no longer used.

With this type of closure, the following objections and disadvantages may be raised: The most marked objection is on the part of the patients, who, almost without exception, complain of pain in the incision. In spite of using the most pliable silver wire we can get it is more stiff than other suture material, and causes more pain than the average "tension" or "stay" sutures. Second, there is usually some infection around the wire. This may be

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minimal and the incision itself heal without infection, but it is rare to have no discharge from the wire holes, although this is no greater than that which occurs around other sorts of "tension" or "stay" sutures in the same kind of cases. Third, there is usually some cutting of the wires into the skin, which causes an obvious cross-hatching of the incision, and in patients with a tendency to keloid formation this may lead to a disfiguring scar. Fourth, the theoretical objections of incomplete closure of the peritoneum predisposing to hernia and obstructive intra-abdominal adhesions have not been borne out in fact. Fifth, we have never seen a block slough of the tissue enclosed by the sutures, although the possibility of occurrence has been a source of worry.

It is our opinion that the method offers the following advantages: First, the closure is very secure. In spite of severe infection, we have had no case



FIG. 3.—Photograph of wound five days after closure with silver wire.

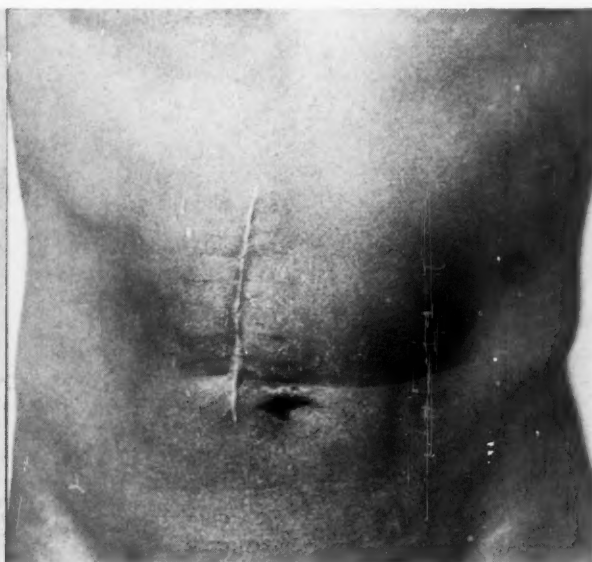


FIG. 4.—Photograph of wound several months after through-and-through silver wire sutures.

of post-operative rupture of the incision and no evisceration. In two cases of the 334 reviewed a loop of bowel or bit of omentum slipped out between the wires which were too far apart or not sufficiently tight. One additional case of this sort occurred in 1933 which is not included. Second, the closure can be carried out very rapidly, so that patients in critical condition can be got off the operating table very quickly after completion of the intra-abdominal manipulations. Third, it can be used to close an abdomen under tension; for example, in the case of an intestinal obstruction, and when other sutures fail to hold. Fourth, an incision of this sort can be easily reopened by untwisting the wires, if a second operation is necessary shortly after the original one. The wires can be pulled aside, the necessary procedure carried out, and the wires pulled up and retwisted. Fifth, in cases of peritonitis or potential infection, such as is present after the perforation of a hollow viscus, the

closure with interrupted sutures allows the escape of peritoneal exudate between the sutures without the placing of drains. The absence of any suture material directly in the line of closure of a contaminated incision predisposes to more benign wound healing and reduces the liability to infection. Sixth, the closure is so secure that old and debilitated patients can be got out of bed very early, as soon as five to seven days after an operation through a long rectus incision. Seven, the incidence of post-operative ventral hernia is no greater than after other more formal types of closure in the same types of cases, so far as we have been able to determine. Although late follow-up records are not available in many of the patients, we know of only three in which hernia has occurred.

A short tabular review will show clearly the types of case in which we use this closure and our increasing use of it.

TABLE I
Number of Cases by Years

1922.....	1	1928.....	45
1923.....	8	1929.....	31
1924.....	16	1930.....	38
1925.....	23	1931.....	51
1926.....	38	1932.....	54
1927.....	29		
Total eleven years. 334			

TABLE II
Number of Cases According to Lesion Present

Gunshot wound of abdomen.....	126
Intestinal obstruction.....	57
Ruptured peptic ulcer.....	45
Gall-bladder operations.....	21
Stab wound of abdomen.....	20
Carcinoma stomach and colon.....	15
Post-operative evisceration.....	8
Traumatic rupture hollow viscera.....	8
Miscellaneous (peritonitis, ileus, pancreatitis, gangrene of bowel, etc.).....	34
Total.....	334

It is interesting to note that there have been only eight cases of post-operative evisceration in eleven years and none of these occurred when silver wire was used. We attribute this low incidence to the fact that we use silver wire to close practically all wounds in which evisceration is prone to occur. In this connection we wish to call attention again to the fact that in the year 1922 alone, four cases of post-operative rupture of wounds occurred following operation for penetrating gunshot injuries of abdomen in which closure was done with continuous catgut suture of the peritoneum, interrupted catgut suture of the fascia, reinforced with silkworm-gut "stay" sutures.

When silver wire is used in this manner, the sutures are ordinarily removed about sixteen to eighteen days after operation. If they are found

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to be too tight at any time, they can be loosened by untwisting them, allowing a little slack to be taken up by the wound and retwisting them. A statistical study of our cases in which the data were complete showed that the shortest time at which any sutures were removed was six days, the shortest time before all were removed was ten days, and the longest any were allowed to remain was thirty-seven days. Ordinarily, part of them are removed about the fifteenth or sixteenth day, and the remaining ones the seventeenth or eighteenth day, though at times all of them are removed at one stage. The accompanying table shows the times at which the first and last wires were removed.

TABLE III

	<i>First Sutures Removed</i>	<i>Last Sutures Removed</i>
Earliest.....	6 days	10 days
Latest.....	25 days	37 days
Average.....	16.13 days (142 cases)	17.81 days (119 cases)

Infection of the wound is of frequent occurrence, as was pointed out earlier. This is to be expected from the nature of the cases in which the method is used. In the study of our 334 cases, sufficient data regarding infection were available in only 194. Infection is listed in the accompanying table as severe, moderate, mild, and none. By these designations the following conditions are to be understood: "Severe" is applied to those in which there was marked infection with induration, profuse purulent exudate, and gangrene and slough of the deep structures. "Moderate" indicates those in which there was redness, induration, purulent exudate, but little or no slough. "Mild" refers to those in which there was slight redness and induration of the suture line with a little exudate from the suture holes only or from only a portion of the incision. "None" indicates no purulent exudate, though induration and redness may have been present.

TABLE IV

Incidence of Infection in 194 Cases

	No. of Cases	Percentages
Severe.....	33	17 %
Moderate.....	48	24.7 %
Mild.....	69	36 %
None.....	44	22.6 %

In the follow-up examinations to determine the presence of hernia as a late complication, only thirty-one patients were seen sufficiently long after operation to justify an estimate as to the solidity of the wound. In three of those that were examined more than six months after operation a hernia was present. In these three cases one had a fecal fistula develop through the wound following operation for intestinal obstruction; one had severe infection; the third had no infection, but developed cirrhosis of the liver with ascites. The inference is that the incidence of hernia is low, but both the

proportionate and the total numbers of our cases are too few to permit conclusions to be drawn.

In addition to these cases in which silver wire alone was used in closing the abdominal wall, it has been found that there are 199 additional cases in which silver wires were used as "stay" sutures, the remainder of the closure being done in layers. This use of wire sutures has developed during the past three or four years, but is being used with increasing frequency in borderline cases in which infection of the incision is liable but not certain to occur, and when in addition, the condition of the patient does not require a rapid closure. It is more secure than when silkworm gut is used.

In conclusion, we wish to present briefly some of the important features of a few cases in which the silver-wire suture had some interesting bearing.

UNUSUAL CASES.—CASE I.—(J 75.) J. McD. *Gunshot wound of the abdomen with multiple perforations of the intestine.* At operation only three silver wires were available. Wound closed with three silver-wire sutures, alternating with three sutures of triple strands of silkworm gut. On the second day the patient became irrational and got out of bed, and the silkworm-gut sutures broke. He was returned to the operating room and three additional silver-wire sutures were put in. The wound became moderately infected. Sutures removed twelfth and sixteenth days, and patient discharged thirty-second day.

CASE II.—(J 7080.) P. G. *Gunshot wound of the abdomen with perforations of the intestine and cæcum.* On the fourth day a loop of bowel came out between two sutures. Two sutures removed and five new ones inserted. Patient died on tenth day—peritonitis.

CASE III.—(N 7287.) J. J. *Gunshot wound of the abdomen with perforations of the intestine.* On seventh day an intra-abdominal abscess drained spontaneously through the incision, but while there was severe infection there was no evisceration. First suture removed twenty-fifth day. Patient discharged fifty-third day.

CASE IV.—(Q 7079.) A. W. *Gunshot wound of the abdomen with perforations of the intestine. Operation.* Closure of perforations and jejunostomy. At close of the operation in removing the drapings the jejunostomy tube was pulled out. Patient redraped. Silver wires untwisted, tube reinserted and wound closed again. Moderate wound infection. Stitches removed twenty-first and twenty-second days. Patient up twenty-fourth day. Discharged fortieth day.

CASE V.—(P 674.) J. W. *Gastric ulcer, excised, gastroenterostomy.* Omentum came out between wires sixth day. Two new wires placed. Moderate wound infection. Sutures all removed twenty-first day. Patient up twenty-fifth day. Discharged twenty-eighth day.

CASE VI.—(L 5369.) G. M. *Crush of liver.* Packed with gauze roll. Pack removed second day by untwisting wires and then tightening them up again. The patient developed subphrenic and intra-abdominal abscess. Severe wound infection. In hospital 104 days. No hernia at time of discharge.

CASE VII.—(Q 11668.) H. P. *Intestinal obstruction.* Jejunostomy done. Patient up in chair seventh day. Walked twelfth day. Sutures out eighteenth day. Wound healed per primam.

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SOME LIMITATIONS OF ENTEROSTOMY

BY ALEXIUS McGLANNAN, M.D.

OF BALTIMORE, MD.

ALMOST from the beginning of surgery some means of opening the distended loop has been the accepted method for treatment of acute intestinal obstruction. (McIver: *Amer. Jour. Surg.*, new series, vol. xix, p. 167, January, 1933.)

Unless it is the result of complications, death is due to toxæmia. Experimentally, a high obstruction can be produced without interference with the vascular supply, but Jenkins and Beswick (*Arch. Surg.*, vol. xxvi, p. 427, March, 1933) note that in some of their cases death may have been due to obstruction. Clinically, interference with the vascular supply of the distended loop makes changes occur in the mucous membrane in all obstructions of the small intestine.

Whenever there is interference with the nutrition of the epithelium there is toxæmia. (Van Buren: *ANNALS OF SURGERY*, vol. lxxii, p. 610, November, 1920.) It is possible to have a simple high obstruction without toxæmia but this is very rare and can only occur early in the course of the disease. Here intravenous injection of a solution of sodium chloride (Orr: *ANNALS OF SURGERY*, vol. xciv, p. 732, October, 1931) or better the salts of sodium, potassium and calcium properly buffered (Elman and Hartman: *Graham's Year Book Publishers*, p. 415, Chicago, 1932) is necessary for the prolongation of life. With toxæmia some method of getting rid of the toxic material must be added to the introduction of the electrolytes. In such a case it is obvious that enterostomy alone will not cure the patient.

High obstruction is a rare condition; it occurred only eight times in the 335 cases reported by McIver from the Massachusetts General Hospital. (*Arch. Surg.*, vol. xxv, p. 1104, December, 1931.) Unless the cause of the obstruction is removed a simple enterostomy above the obstruction will allow the contents of the high intestine to flow out without relieving the obstruction, a condition which is borne but a short time by the host in spite of the administration of sodium chloride and water hypodermically. This limits the value of enterostomy in high obstruction.

With the slightest degree of strangulation the absorption of toxins ensues and the treatment with salt solution does not prevent death from toxæmia. (Gatch: *Amer. Jour. Med. Sci.*, vol. clxxiii, p. 660, June, 1927.)

Lower down in the intestinal tract the fall in the salts of the blood is not as prominent as is the toxæmia. Here enterostomy added to whatever is the proper treatment of the obstruction may be the life-saving feature. If the enterostomy is delayed, air pockets and particularly paralysis of the bowel will prevent its action and the patient will die from his obstruction.

Multiple enterostomy, opening the bowel in two or more places, or a high enterostomy above the paralytic portion may be a dangerous expedient. The greater the damage to the bowel the more marked the toxæmia and the height of the obstruction plays some part in the outcome of the disease.

In the great majority of acute intestinal obstructions some degree of dehydration is present. Proper administration of adequate volumes of salt solution before and after operation will be a factor in the outcome of certain cases.

If enterostomy is performed above the point of obstruction, tension will be relieved and the bowel regain its tone. Recent fibrinous adhesions will often be absorbed.

When the patient is very sick enterostomy is done under local anæsthesia without a thorough exploration, but there is some danger of overlooking a strangulation.

In the large intestine the obstruction almost always originates from within the bowel and only in the late stage involves the vessels. Whether it is due to involvement of the lumen alone or not, enterostomy across the abdomen from the seat of the obstruction is a useful preliminary. We have had experience with enterostomy where the flow of material was fast and where it was slow. Probably the best results had followed a slow flow of the material because this has made slight impression on the blood pressure. But we have had some brilliant results follow a rapid flow of the material.

The toxin of intestinal obstruction is probably due to bacterial action on the contents of the obstructed loop, (Gatch: Surg., Gynec., and Obst., vol. xlv, p. 332, March, 1928), although the experiments of several observers point to an altered action of the glands of the intestinal wall and pancreas as the cause of the toxin. Thus Whipple, Stone and Bernheim and later Whipple and other associates (Jour. Exper. Med., vol. xix, p. 166, 1914), (Jour. Amer. Med. Assn., vol. lxvii, p. 15, 1916), isolated a proteose from the toxic contents of an obstructed loop of duodenum. Whatever the nature of the toxin it is deadly to animals of the same species and a man who has received his lethal dose will die in spite of any attempt at treatment. For this toxin we have no anti-toxin or antidote.

Enterostomy is useless in the presence of such a dose. Unless a patient is moribund we have no means of estimating the dose of toxin which he has received or the extent of paralysis of the bowel before the abdomen is opened. Enterostomy under such circumstances is a forlorn hope.

In about 300 cases 77 per cent. of the non-gangrenous patients were cured by enterostomy. However subtle may be the exact cause of death in intestinal obstruction, there can be no doubt that the accumulated material in the occluded bowel is extremely toxic and has a considerable influence on the production of toxæmia. Therefore it is necessary that in the presence of toxæmia we provide an outlet for this accumulated material by making an opening into the bowel above the obstruction. Whether we shall do more depends on the general condition of patient and his lesion.

RUPTURE OF THE LIVER WITHOUT TEAR OF THE CAPSULE

BY D. E. ROBERTSON, M.D., AND ROSCOE R. GRAHAM, M.D.

OF TORONTO, CANADA

CASE I.—On the 20th of October, 1932, a boy, aged fifteen years, received a blow to his epigastrium while playing football. He was knocked on to his back. He was able to get up with difficulty, and after resting, he cycled home. On his way home he had a "spell" and had to rest for a while. On arrival home he felt better and when his physician was called to see him that night, the physician could find no abnormality excepting a complaint of tenderness in the epigastrium. No rigidity was noted. The boy slept fairly well that night, but was somewhat disturbed by pain in his right shoulder, so that he was under the impression that he had injured the shoulder in his fall. He was confined to bed the next morning by order, but he was allowed up for lunch. During his lunch he was attacked by a very severe pain in his epigastrium, which was followed by vomiting. The vomitus was clear of blood. He was seen by his physician late in the afternoon, after having three or four hours of agonizing pain. His physician found the boy in shock, with a pulse of 130, complaining of inability to lie on the left side on account of pain being made worse. He had pain just under the right shoulder-blade and in the epigastrium. A large round swelling was to be seen just below the right costal margin.

I saw him early in the evening, when his condition was not materially changed. His shock was pronounced. Examination of his abdomen revealed the large round swelling in the epigastrium, but to the right of the mid-line, seeming to arise from under the costal margin, and seeming to be attached to the liver. The margin of the liver could not be felt. There was no general peritoneal tenderness, and there seemed to be no peritoneal irritation. There was no rigidity of the abdominal muscles. The veins of the skin of the lower abdomen were engorged and stood out prominently.

It was felt that a transfusion might be of benefit in improving his condition. He was therefore transfused with 450 cubic centimetres of blood, but this in no wise influenced the condition, insofar as one could judge.

The agony of the patient made it imperative that there be some active surgical interference. On reviewing the history of the events, and having consideration for the physical findings, *viz.*: the absence of peritoneal irritation; the presence of the tumor; its intimate relation to the liver; the great distress and the high degree of shock, together with the enlargement of the superficial veins, made it appear that he had a hæmorrhage in which increasing pressure was the factor producing the great disturbance. The physician suggested this was a rupture of the liver without tear of the capsule. It was decided to operate upon him.

Under general anaesthesia the abdomen was opened and the liver was immediately seen to have a large swelling on its anterior aspect extending up over the dome. This tumor was dark red and looked like an enormous blood blister. It did not extend quite down to the inferior margin of the liver. The general peritoneal cavity had no excess of fluid present and there was no free blood. The gall-bladder was markedly œdematous. An aspirating needle was introduced into the hæmatoma under the capsule of the liver and ten or fifteen cubic centimetres of blood aspirated, when the needle became blocked. On withdrawing the needle the blood spurted through this small opening in the capsule to the height of six or eight inches, which demonstrated the enormous pressure present in the hæmatoma. The capsule was opened widely to allow the complete evacuation of the cavity, and the exploring finger was able to identify a rent in the liver substance, but on

account of the clots that were present it was impossible to determine the extent of the tear in the liver. A drainage tube was introduced into the cavity and the capsule closed, which was readily accomplished, with catgut. A stab wound was made in the abdominal wall opposite the cavity and the drainage tube pulled through this. The abdominal wound was then sewn up.

The first eighteen hours following operation proved to be fairly stormy—high temperature; fast, thready pulse. It was necessary to transfuse the patient again twelve hours after operation. This improved his condition considerably. His pulse rate was in the neighborhood of 140 for the next day or so, with some irregularity of the heart. There was considerable drainage from the tube for the first forty-eight hours, but at no time, either during the operation or subsequently, was there any sign of bile. After forty-eight hours the tube was removed, and there was further discharge for another forty-eight hours when it finally closed. The patient went on to make an uninterrupted and complete recovery, and at the present time, May, 1933, he appears entirely well and has no limitation of activity.

CASE II.—(DR. ROSCOE R. GRAHAM.) A boy, aged fourteen years, was injured in an automobile accident on December 10, 1932. The manner of the accident is of some importance. While sitting in the back seat of a car, a collision occurred, in which he was thrown violently forward, striking his lower right chest on the back of the front seat.

Examination at this time by Dr. Kenneth Sinclair, of North Bay, Ont., showed a fracture of the fourth, fifth, sixth and seventh ribs on the right side near the spine. He was admitted to hospital, where he remained for about ten days. On admission his pulse rate was 140, and took about three days to reach 90. It was accompanied by a slight fever. Stereoscopic röntgen rays of the chest taken at this time showed some slight elevation of the dome of the diaphragm on the right side, but no evidence of fluid in the pleural cavity, and the fracture of the ribs could be demonstrated.

He returned home until January 1, 1933, at which time he reported to his physician, who discovered a large tumor in the right upper abdomen. At this time his pulse was 96 and his temperature 97.4°. He did not seem to be suffering any undue pain, and had no great dyspnoea, but during his stay at home he did complain, not only of some discomfort in the right upper quadrant, but also of pain at the tip of the right shoulder. At this time stereoscopic röntgen rays of his chest were taken, and showed the diaphragm had reached the level of the third rib anteriorly; still no evidence of fluid in the pleural cavity. Movement of the diaphragm on fluoroscope was greatly restricted.

A barium meal was given, and this showed the greater curvature of the stomach displaced to the left, and also a very marked displacement to the left of the descending duodenum.

He was then placed under our care in the Toronto General Hospital, and consultation with Professor Duncan Graham gives the following notes:

"On examination there was no expansion of the right chest below the fourth rib. The trachea was in the mid-line. On percussion, resonance was impaired from the second interspace downwards in the mid-clavicular line. The impairment was more marked from the fourth interspace downwards. The findings at the same level in the mid-axillary line were the same. Skodaic resonance was absent above the area of more marked impairment of resonance. Breath sounds absent over area of definite dullness; normal over remainder of chest. Marked fulness in right upper abdomen extending across the mid-line to near the mid-clavicular line on the left side. This latter area was dull to percussion, but not tender. Traube's space was obliterated, and cardiac impulse was in the fourth interspace on the left side. No definite edge to the liver could be felt. Temperature, 99°; white blood-cells, 8,000. The findings suggest a collection of fluid between the liver and diaphragm, more marked on the right side, but extending across the middle line and obliterating Traube's space. As toxic symptoms are absent, and some degree of fulness has been present for over three weeks, subphrenic abscess is un-

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likely. In view of the history of the injury, the condition suggests a subcapsular hæmorrhage of the liver."

With the above findings, it was considered advisable to explore his abdomen, which was done under spinal anæsthesia on January 6, 1933. The following are the details of the operative note:

"The abdomen was opened by displacing the upper right rectus laterally, and one found the huge mass to be a collection of fluid confined within the capsule of the liver, extending quite up to the third rib. One could pass the hand over the dome of the liver. There were some fine, filmy adhesions, but there was no rent in the capsule. The base of the liver was shoved downwards by this huge collection of fluid, and explained the displacement of the duodenum and greater curvature of the stomach to the left, and it displaced the falsiform ligament well to the left side, also explaining the physical signs of obliteration of Traube's space. The capsule of the liver was then incised, and over two quarts of old blood and bile were evacuated. There was no evidence of infection. The surface of the liver as palpated through the opening in the capsule seemed to be rough and irregular, and bled fairly freely, but there was no alarming blood loss. There seemed to be some diminution in the volume of the right lobe of the liver. One could not determine anything grossly disturbed in the left lobe. A stab wound was made to the right of the laparotomy wound, and the edge of the capsule sutured to the peritoneum and fascia, thus marsupializing it. The cavity was then loosely packed with gauze saturated with an aqueous solution of 1 in 1000 acriflavine."

Progress.—Twenty-four hours post-operative the fulness had almost entirely disappeared in the upper abdomen and Traube's space was more resonant. The upper level of the diaphragm on the right side was still at the third interspace. The degree of shock following operation was not great, his pulse never exceeding 130 and the temperature never going above 102°. This gradually came down over a period of two weeks, until the temperature rarely exceeded 99° and the pulse rate rarely exceeded 100. There was still a fairly free discharge from the wound.

January 25, 1933.—The patient was comfortable, walking about; dulness in Traube's space more marked. Liver palpable on the right side two fingers below the costal margin; upper level of the diaphragm third rib; some lateral movement of the right lower chest, but no movement antero-posteriorly. It was evident that the liver was not in contact with the diaphragm. Discharge from the wound has been very much less, and despite attempts at exploration of the cavity, no great volume could be evacuated. Discharged from hospital January 30. Still some drainage. General condition excellent.

February 6, 1933.—Patient observed under the fluoroscope. The dome of the right diaphragm at the third rib shows very little movement. Left diaphragm moves well. There is a definite collection of air between the diaphragm and the liver. Dulness in Traube's space has decreased. Patient complains of aching pain in the right shoulder on attempting to straighten up. General condition excellent.

February 16.—Patient spontaneously evacuated over a quart of bile and blood-stained fluid through the sinus.

March 23.—Still fairly free discharge from the sinus. General condition excellent. Gaining weight and suffering no disability. Röntgenogram of chest shows that the dome of the diaphragm was at the level of the fifth rib mid-axillary line.

May, 1933.—Discharge ceased in April. Now well in every respect.

In reviewing the literature, we have been able to find three communications dealing with this lesion:

Wulsen¹ reports the case of a girl who suffered an abdominal injury by colliding with a fence while riding upon a sled. Following an acute shock, accompanied by vomiting, this girl improved, but was not able to leave her bed, and four weeks after the accident was admitted to hospital. There had been no fever, but she had vomited bright red blood

and had persistent epistaxis. The abdomen was slightly distended. There was diffuse tenderness in the region of the liver and the spleen, the liver being about four centimetres below the costal margin. Her hæmoglobin had dropped to 27 per cent. and her red cells to 1,120,000 with 9,200 white blood-cells. She was carried on intravenous glucose therapy, and at times developed a fever which would reach 103°. The stools were free, and of coal-black color. The hæmoglobin decreased to 19 per cent. Röntgenogram showed the right diaphragm a hands-breadth higher than the left; no purulent exudate. Death occurred on April 13. Autopsy findings revealed a cavity about the size of a child's head in the upper portion of the right lobe of the liver. The capsule of the liver was intact everywhere. The cavity contained large quantities of old blood clot in a dirty brownish-red fluid. At several sites the coagula had a greenish color. The upper margin of the right lobe of the liver was at the level of the third rib. Numerous subpleural and subpericardial ecchymoses; similar ecchymoses in the mucosa of the small bowel and in the pelvis of both kidneys. The remote vascular lesions were presumed to be the result of decomposition products developing in the cavity producing toxic vascular lesions.

Brandberg² reports a boy fourteen years of age who suffered an abdominal injury while riding a bicycle and colliding with a bus. This patient, in addition to fractures of the arm and an avulsion of the right sacro-iliac joint, had hæmaturia. This gradually cleared up, as did a slight abdominal sensitiveness. The patient, however, continued to complain of paroxysms of pain radiating from the epigastrium to the left shoulder. The attacks lasted from five to ten minutes and occurred several times daily. Thirty days following the injury, tenderness in the abdomen had increased, and there was a definite sense of mass. Laparotomy was performed. A large subcapsular collection of about three litres of bile was evacuated, and the capsule marsupialized. This patient went on to recovery. Brandberg also reports six other cases of similar injury following the same trend of clinical course.

Anderson³ reports the case of a laborer thirty-six years of age who was run over by an automobile. Four days after admission he suddenly collapsed from what was evidently an abdominal hæmorrhage. At laparotomy they found delayed rupture of the spleen, with about two litres of free blood in the abdomen. Two weeks following this operation the patient became jaundiced, developed a right-sided pleurisy, and the right diaphragm was high and immobile. Nine days later exploration was done for a subphrenic abscess, and it was found instead that there was an abscess in the liver, with an intact capsule. This case probably represents an incidence of a subcapsular rupture which subsequently became infected. The fact that the organism cultured was a diplococci leads one to believe that the source was through the blood-stream, rather than from the bile passages.

Comment.—There are several interesting factors which are worthy of consideration in the two cases presented, which show a striking similarity to the cases which have previously been reported. In all the recorded cases, and in Case II of this group, the length of time which elapsed between the injury and the recognition of the fact that the patient was suffering a serious injury is remarkable. In all except Case I here reported, the tumor has not been present at the time of the original examination following the injury, but has slowly developed and has been recognized some days or weeks later. We are led to conclude that the rapid appearance of the tumor, and the early recognition of a serious accident in Case I, is explained by the fact that the content of the subcapsular tear was largely blood. This was substantiated at operation, where practically no bile was found in the cavity, whereas in Case II and in the cases reported in the literature, the tumor was largely produced by the slow accumulation of bile mixed with blood in the

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subcapsular rent. Both the reported cases were complaining bitterly of pain referred to the right shoulder, which is interpreted as being due to irritation of the diaphragm, and this finding in a patient who is suffering an abdominal injury is probably of real significance and worthy of careful consideration before being dismissed.

The height to which the diaphragm was able to rise in Case II was remarkable, when one considers that it was due to a subcapsular effusion, and that the capsule remained intact. We have seen displacement of the diaphragm to this degree previously, only in cases of very severe ascites.

The absence of fluid in the chest, and the absence of physical findings on examination of the chest, apart from skodaic resonance, we believe to be of real value, and the finding of this resonance is helpful in excluding an associated hæmothorax.

In Case II and in the reported cases the initial high fever is difficult to explain except as a result of broken-down blood-cells and decomposition product resulting from damaged liver tissue. That this effusion can remain uninfected for such a long time is most interesting, and in the reported cases we were able to find only Anderson's³ case in which there was a late infection of the contents of the cavity, which he concluded was of a hæmatogenous origin.

Conclusions.—(1) Two cases of subcapsular rupture of the liver with operation and recovery are reported.

(2) In Case I the seriousness of the injury was recognized early, the tumor appeared early, and at operation the cavity was found to be filled only with blood.

(3) In Case II there was a long latent period of well being between the accident and the appearance of the tumor, which at operation contained bile and blood, and was accompanied by gross destruction of liver tissue.

(4) If a patient suffers an abdominal injury with distress referred to the right side and accompanied by pain in the shoulder, early exploration is advisable, as there will be a shorter convalescence and it will avoid destruction of liver tissue should the diagnosis prove to be a subcapsular rupture of the liver.

(5) If the tumor occurs soon after the injury, we presume its contents will be blood, and drainage with a tube appears to be the ideal method of handling it. If, on the other hand, it is late in forming, bile will constitute an important volume of the content of the cavity, and marsupialization is desirable.

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FOREIGN BODIES IN THE BILIARY TRACT

BY CLARENCE G. TOLAND, M.D.

OF LOS ANGELES, CALIF.

FOREIGN bodies in the biliary tract are rarely encountered and seldom suspected until seen at operation or at the necropsy table. Their occurrence is so infrequent they are not mentioned in many text-books on diseases of the biliary system. Perhaps as pathological curiosities they merit little attention in standard text-books. To the individual surgeon who has been confronted by one of these unusual cases they present many interesting and puzzling features. We wish to review the literature and to report an additional case.

CASE.—A male, aged forty-nine, was admitted to the hospital December 2, 1932, with a chief complaint of jaundice. The family and past history were irrelevant. He never had had typhoid fever. His health had been excellent until about one year prior to admission when he began to have occasional pain in the upper right abdomen. There was no jaundice or any other untoward symptoms. The attacks were not severe. An X-ray dye study revealed a pathological gall-bladder and an operation was advised.

On June 2, 1932, a cholecystectomy was performed by another surgeon. There were no gall-stones present. The head of the pancreas was enlarged and the liver showed pathological changes. The common duct was not opened. A Penrose drain was used for drainage. Three days after operation a sudden severe jaundice developed. There was no pain, chills or fever but on the fifth day he developed considerable upper abdominal pain. The jaundice persisted about three weeks, clearing gradually. For about four months he felt fairly well, but he did not regain his strength and continued to have mild indigestion. There was no jaundice or itching and the stools were brown. Then he began to notice a slight jaundice. There was no pain. The urine was dark and the stools light in color. The jaundice became gradually worse up to the time of his admission. It would improve at intervals and the stool would show some bile. The itching of his skin was very troublesome. He felt weak and had occasional nausea. He lost about twenty pounds in two months. During this period blood examinations showed an anemia, and the possibility of a primary anemia was considered.

There were no symptoms referable to the cardiovascular, pulmonary or nervous systems.

The blood-pressure was 134 systolic and 88 diastolic. The pulse averaged 76. There was a diffuse moderately severe jaundice involving the skin, mucous membranes and sclera. There were numerous scratch marks from the itching. The head, neck, chest, and heart revealed no abnormalities. There was a scar in the anterior abdominal wall of an operative incision through the upper right rectus muscle. The liver was enlarged four centimetres below the costal margin. The spleen was readily palpable. There were no areas of tenderness. The extremities, reflexes, and genito-urinary examination showed no abnormalities.

Laboratory Tests.—The icteric index ranged from 20 to 120 over a period of three weeks. The Van Den Bergh gave an immediate direct reaction and a positive indirect reaction. Blood count: Hæmoglobin, 68 per cent.; red blood-cells, 3,100,000; white cells, 9,000; polymorphonuclears, 70 per cent. Urine: Trace of albumin. No sugar. Two plus indican. Two plus bile. Occasional hyaline cast. Kahn test: Negative. Fragility test: Normal. Bleeding time: Sixteen minutes.

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A diagnosis of common-duct obstruction the result of a cicatrix was made. The possibility of a carcinoma of the head of the pancreas was considered. Two blood transfusions of 800 cubic centimetres each were given over a period of a week and an operation was performed December 24, 1932.

Operation.—Under ether anæsthesia the old right rectus scar was excised and the liver exposed. It was very dark and considerably enlarged. The common duct was buried in dense adhesions and was exposed with extreme difficulty. An incision in its lower portion exposed a black, spongy, somewhat friable mass. Its removal released a large amount of bile. The mass measured about one times one times five centimetres. It was sent to the laboratory. A good-sized catheter was sutured into the common duct, two Penrose drains were placed beneath the liver, and the wound was closed.

Pathological Report.—Cotton gauze impregnated with bile, bile salts, and fibrin.

Post-operative Course.—Large quantities of bile drained almost immediately from the catheter in the common duct. The jaundice improved rapidly, the urine became lighter, and the stool showed some bile. The course was fairly smooth and the prognosis favorable until the ninth day when some bleeding from the wound was noted. He had a slight chill and the temperature rose to 100° . The bleeding gradually increased until the wound partially separated and on the twelfth day the wound was packed in an attempt to control the hæmorrhage. The chills persisted intermittently and the temperature increased to 104.2° on the twelfth day. Blood transfusions of 800 cubic centimetres to 900 cubic centimetres were given on the second, seventh, and eleventh days. The jaundice increased rapidly from the ninth day until the thirteenth post-operative day, when death occurred. Unfortunately, no autopsy could be obtained.

Comment.—The correct diagnosis as to the cause of the jaundice was not made until operation. No foreign body in the biliary tract ever had been encountered before and we were familiar with no criteria for such a diagnosis.

Sir Humphrey Rolleston,²⁷ in his book on "Diseases of the Liver, Gall-Bladder, and Bile Ducts," says in commenting on obstructive jaundice, "suspicion as to the nature of such foreign bodies must always arise unless the constituents of gall-stones has been definitely proved." It is rare that such a suspicion as a cause of obstructive jaundice is thought of.

It is perhaps more reasonable to be suspicious of a foreign body obstruction in the case of inexplicable jaundice arising soon after an operation on the biliary system. If the biliary system has been thoroughly explored one is familiar with the complications to be anticipated. If obstructive jaundice develops in an abrupt fashion, foreign-body obstruction must be included in the list of tentative diagnoses.

In very few of the reported cases was it mentioned that the possibility of a foreign body was considered. It is obviously a difficult diagnosis to make, particularly in those patients on whom no surgery has been done. There often is no history of any foreign body having been swallowed and if so, the symptoms occur after an interval late enough to cause no suspicion of a causal relation.

Most of the reported cases have appeared in the last twenty years, but one of the earliest reports was by Nauche,⁵ who in 1878 found a steel needle in the gall-bladder.

Fruit seeds, cherry stones, and round worms were encountered years ago and are the foreign bodies mentioned in those text-books which consider

foreign bodies. Bullets, needles, thread, gauze, rubber tube drains—all have been found in the biliary tract.

In 1914, a German soldier was shot in the upper right abdomen. Attempts to remove the bullet were unsuccessful. Fifteen years later Goldhan²⁰ operated because of severe pain. The bullet was found lodged in the cystic duct with the apex downward. His belief was that the bullet originally had lodged in the liver and had migrated downward by the hepatic duct.

Eastman⁶ reports the presence of steel needles in the gall-bladder as the nuclei of gall-stones. Adhesions were present between the fundus of the gall-bladder and the pylorus. He believed the needles had been swallowed and had then passed directly from the pylorus into the gall-bladder. He thought this was the most logical explanation for the presence of fruit stones in the gall-bladder.

Many cases of recurrent gall-stones have been reported following cholecystostomy in which bits of suture material used in the first operation were nuclei for the gall-stones. Hall¹⁴ mentions finding two unique worm-like stones in the gall-bladder three years following a cholecystostomy. A piece of suture ran the full length of each. This probably was the purse-string suture from the first operation.

Foreign bodies in the biliary ducts occur more rarely than in the gall-bladder. Oppel's¹⁷ case is in many ways similar to ours. Four months after cholecystectomy, the patient developed a fatal peritonitis. At necropsy, a swab was found in the common bile-duct. There had been no incision made in the bile duct at the time of the cholecystectomy.

A patient of Cooke's¹⁹ had neither jaundice nor colic but was operated on because of a greatly enlarged gall-bladder. Some stones were found in a distended gall-bladder and one in the cystic duct. From the common duct was removed a piece of bent, slightly corroded wire, one inch in length.

Federoff²⁰ describes an unusual accident while removing a T-shaped rubber tube drain from the common bile-duct of a patient. The stem of the T-shaped tube was discharged in the dressing and the horizontal part remained in the duct. Five months later the patient developed colic, jaundice and fever, but recovered and remained well for two and a half years when he had several similar attacks in rapid succession. Radiograms showed the drainage tube in about the same position but nearer the duodenum. A laparotomy was performed and the tube removed, five and one half years after the first operation. The patient made a complete recovery.

An insane woman reported by Lemierre and Pollet²¹ swallowed the handle of a spoon. Apparently by way of the ampulla of Vater it penetrated into the common bile-duct and led to the development of diffuse liver abscesses.

Eichelster²² found a piece of thread from a drainage strand of a former operation in the common bile-duct.

Some absorbable catgut ligature used in a cholecystectomy led to the development of a curious foreign body tumor with stricture of the common duct in a patient described by Hammesfahr.²³

The mechanical explanations for foreign bodies arriving in the biliary system are as bizarre as the explanations for the course of migration of foreign bodies anywhere in the body.

It is logical to assume needles and other sharp objects that have been swallowed and reached the pylorus might migrate by direct contiguity into the gall-bladder. The curious circumstances that lead to such migration are difficult to visualize. Inanimate foreign bodies in the gall-bladder can hardly be explained on the basis of retrograde migration from the duodenum through the ampulla of Vater, but the motile round worms could easily reach the gall-bladder by this route.

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A review of the reported cases would indicate that foreign bodies in the gall-bladder may be there for years giving rise to few symptoms as in the case of silent gall-stones. In the biliary ducts, however, colic, fever, and jaundice usually develop within a few months and lead to operation.

Conclusion.—A case is reported of common bile-duct obstruction by gauze following cholecystectomy and the literature reviewed. The necessity for the inclusion of possible foreign-body obstruction as one of the tentative diagnoses for the cause of jaundice following cholecystectomy is suggested.

TYPES OF FOREIGN BODIES IN BILIARY TRACT

(1) *Cystic Duct* (Rifle Bullet). Shot in right abdomen in 1914. Operated by Goldhan²³ in 1929. Thought that bullet entered liver, then hepatic duct to cystic duct.

(2) *Gall-Bladder* (Seeds and Worms). (Mertens,² Deaver,³ etc.) (Steel Needles.) (Nauche⁴ and Eastman.⁵) Thought to have been swallowed, then migrated to gall-bladder from pylorus. (Calculi Following Surgery.) Recurrent stones with pieces of suture used at former operation as nuclei. (Homans,⁷ Kehr,⁸ Malcolm,¹⁰ Drummond,¹¹ Flörcken, H.,¹² Hall.¹⁴) (Bristle and Piece of Thread.) (Haughton.¹³) (Gauze.) (Bevan.¹⁵) Removed after interval of eleven years. (Rubber Drain.) (Schulze.¹⁶)

(3) *Biliary Ducts* (a) (Common Duct) swab found four months after cholecystectomy. Common duct had not been opened so probably had migrated from peritoneum. (Oppel.¹⁷) (*Piece of Wire*) Swallowed and migrated to common duct. (Rubber Drain Tube.) (Federoff.²⁰) (Handle of Spoon.) Swallowed by insane woman. (Lemierre and Pollet.²¹) Produced diffuse liver abscess. (Non-Absorbable Catgut Ligature.) Stricture of common duct by foreign-body tumor forming around catgut. (Homans.⁷)

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ACUTE SURGICAL LESIONS OF THE PANCREAS

BY JOHN DOUGLAS, M.D.

OF NEW YORK, N. Y.

THE treatment of acute surgical lesions of the pancreas must depend upon the etiological factors producing the pathological conditions present. It has been recognized that there is a direct relationship between disease of the biliary system and various pancreatic lesions; but just what is this relationship in the different lesions found, and how the biliary disease affects the pancreas is far from being clarified. Even the nomenclature of the disease is a subject of confusion. The lesions are variously reported as acute pancreatitis, acute hæmorrhagic pancreatitis, subacute pancreatitis, cedema of the pancreas, pancreatic necrosis, or chronic pancreatitis. No one term seems to fit all cases, and chronic pancreatitis is included here because what appears to be a minor or chronic lesion of the pancreas may be found at an operation for cholelithiasis or cholecystitis. Then, after what is believed to be the proper form of surgical operation is performed, the patient dies within a few days, and at autopsy the most severe form of necrosis and disintegration of the pancreas may be found.

It has been stated that the mortality has been very little reduced over a period of years. Korte, in 1911, reported 103 cases with 60 per cent. mortality. Schmieden and Sebening, in 1927, collected 1,278 cases with 51.2 per cent. mortality. However, a statistical study of this condition would appear to be of somewhat questionable value because of the varying type of lesions which would be included in such a group of cases.

Operations for acute lesions of the pancreas are not sufficiently common for any one surgeon to have a large enough number of cases to form definite conclusions from his personal experience. In order to get a more definite idea of the disease, all of the cases diagnosed under the heading of acute lesions of the pancreas occurring during the last fifteen years at St. Luke's Hospital were studied. This further confirmed the belief as to the difficulty of reaching definite conclusions from a statistical viewpoint, because of the great variety in description of the pathological lesions found at the time of operation, subsequent histories of patients after operation, pathological conditions found on readmissions or reoperations and findings at autopsies on the patients who died. It was equally difficult to correlate the relationship between the various lesions found in the biliary system and the condition of the pancreas. Although in the vast majority of cases there appeared to be a distinct relationship between biliary disease and the pancreatic lesion, there were a few cases in which there were no gall-stones or gross evidence of biliary disease.

It is unnecessary to review in any detail the various studies as to the

etiology of pancreatic disease since Claude Bernard, in 1856, reported that in animals the injection of certain substances into the pancreatic duct would cause various degrees of acute pancreatic necrosis, which, if severe enough, would result in the death of the animals. Bile mixed with olive oil was used by Bernard. Since then, various other substances have been used in experimental work. Opie, in 1901, correlated this experimental work with a report of an autopsy on a patient dying of acute pancreatic necrosis where a small gall-stone had obstructed the ampulla of Vater. This was followed by other experiments, unnecessary to mention, until Archibald linked up certain other factors, such as the introduction of infected bile, under just sufficient pressure not to overcome the sphincteric action of the sphincter of Oddie, whereby he could cause varying degrees of necrosis of the pancreas. He also enumerated a group of factors, the necessity of the presence of which makes understandable certain conditions in the causation of the disease which would otherwise be hard to explain. These three factors were: First, the changes in the composition of the bile, due to infection, which increases the proportion of bile salts; second, undue resistance, perhaps often amounting to spasm of the common-duct sphincter; and third, abnormal rise of pressure in the biliary system, either in the gall-bladder or common duct.

To add to the confusion of thought, the theory of infection of the pancreas by means of retrograde infection through the lymphatics from the gall-bladder, appendix or a duodenal ulcer has been advocated by Bartels, Arnsperger, Franke, Deaver, Pfeiffer and Sweet. Contradictory evidence appearing to apparently invalidate in certain instances all of the various theories can be instanced, such as a case report of White and Owen in which a carcinoma, extending from the stomach, so dilated the duodenum and the sphincter of Oddie that it allowed free flow of the duodenal contents—bile and pancreatic juice—into the pancreatic duct without any particular change in the pancreatic tissue. It is also a fact that at autopsy the pancreas may be found apparently bile-stained without a necrotic condition occurring. On the other hand, the theory of infectious origin of acute pancreatic lesions would seem to be contradictory of the fact that, although in some cases one finds enlarged lymph-nodes about the common duct and head of the pancreas, the type of lesion found does not coincide with original infectious processes elsewhere and cultures made at the time of operation are nearly always sterile. Furthermore, when a patient recovers without an operation and a residual lesion occurs, instead of occurring as the usual type of abscess, which one expects to find in an infective process, it occurs as a cyst or as an area of fibrosis in the body of the pancreas, surrounding a softened, cheese-like material which is not pus.

Numerous cases are reported where a reflux of bile could not have been the etiological factor because the necrosis appeared to be primary about the duct of Santorini, which entered the duodenum separately from the combined orifice of the duct of Wirsung with the common bile-duct at the papilla. And even where they entered together, the anatomical arrangement in a large

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percentage of cases would not allow biliary reflux. An influx of duodenal fluid might have been the etiological factor in these cases as it has been shown that the injection of duodenal fluid will cause pancreatic necrosis, but, experimentally, this duodenal fluid injection must be made under pressure.

The symptomatology and diagnosis of the acute lesion of the pancreas has been admirably reviewed recently by deTakats and MacKenzie in an article published within the last year in the *ANNALS OF SURGERY*. It is not necessary to repeat this work here, beyond calling attention to the fact that in the twenty-two cases reported by them, the diagnosis of acute pancreatic necrosis was not made in one single instance. The most common diagnosis was acute cholecystitis or common-duct stone and there was present an incidence of biliary infection in eighteen of the twenty-two cases, which gives 81.2 per cent. of biliary infection as a primary cause of the pancreatic pathology. DeTakats also calls attention to the value of the determination of diastase in the blood and urine as a diagnostic aid. He quotes: "Skoog states that while increased values may occur in other acute abdominal conditions, a negative finding, provided that determination is made within twenty-four hours to thirty-six hours after the onset of symptoms, excludes any pancreatic pathology."

A review of the histories of thirty-two cases of acute pancreatic necrosis occurring during the last fifteen years in St. Luke's Hospital has not enabled me to reach any more definite conclusions than I had before such examination. However, there were many observations which did appear to have a distinct bearing on the etiology, pathology, progress and treatment of the lesion present.

(I) It was observed that a number of patients gave histories of previous attacks of upper abdominal pain, previous to their severe attack for which they entered the hospital. (deTakats and MacKenzie report this in nineteen out of thirty cases.) At autopsy on a patient who died following an operation for acute pancreatic necrosis, an area was found at the junction of the body and tail of the pancreas where there was an area of fibrosis surrounding cheese-like material, evidently a result of a previous attack from which the patient had suffered a year earlier and which had been diagnosed as a gall-stone attack. This further demonstrates the possibility of recovery without operation from a rather severe lesion.

(II) There were several patients upon whom an operation was performed for cholecystitis with cholelithiasis or common-duct stone on whose histories the pathological finding, reported at operation, stated that the pancreas was thickened, sometimes moderately in the region of the head, and other times enlarged to two or three times its natural size. In these cases there were usually also observed varying degrees of fat necrosis. Several of these patients after drainage of their common duct, or cholecystostomy, died, and at autopsy a severe degree of pancreatic necrosis, with destruction of the pancreas, was found.

(III) A number of patients in whom only moderately severe lesions were found at the time of operation went on to develop secondary lesions in the pancreas. One patient who had upper abdominal symptoms for six weeks before admission to the hospital, with a history of a severe attack three years previously, was operated upon. The gall-bladder was found to be microscopically normal, there were some areas of fat necrosis and the whole pancreas was hard with no areas of softening. Nothing was done

beyond the exploratory operation. Three weeks later the patient had developed a cyst of the pancreas from which a quart of fluid was evacuated. Another patient who at operation showed fat necrosis with red and greenish areas in the pancreas and a shrunken gall-bladder containing small stones, whose operation consisted of drainage of the pancreas with nothing being done to the biliary tract, recovered from the operation but was readmitted four years later with similar symptoms. An X-ray showed a calcified area in the left upper quadrant of the abdomen, 2.5 centimetres in diameter, which was apparently a calcified cyst in the pancreas. Another patient who had been operated upon for acute pancreatic necrosis in another hospital six years previously subsequently developed three attacks two years apart, during the first and third of which a pancreatic cyst was drained.

(IV) One patient was admitted to the hospital and died in diabetic coma, with a blood-sugar of 840. Autopsy showed hæmorrhages into the pancreas with nothing abnormal in the biliary system.

(V) A patient upon whom a cholecystectomy was done two years previous to readmission had a pancreatic cyst drained and subsequently died from hæmorrhage due to erosion of one of the larger blood-vessels in the region of the pancreas.

(VI) A group of cases who were apparently cured, or discharged from the hospital improved, and readmitted at varying times thereafter, were of special interest. One of them was discharged from the hospital with the wound healed in January, 1920. At the time of operation the head of the pancreas was the size of an orange and there was one gall-stone. A cholecystoduodenostomy was done. Eight years later the patient was readmitted to the hospital with a diagnosis of perforated gastric ulcer. At operation the pancreas was found swollen, hæmorrhagic and soft. Drainage to the pancreas was established, and at autopsy the pancreas was found necrotic throughout. Another patient was operated upon with a pre-operative diagnosis of cholelithiasis. The pancreas was hard with some hæmorrhage and fat necrosis. Stones were present and a cholecystostomy was done. The patient was discharged one month after operation and readmitted a month later with pain and a temperature elevation. Twenty days later the patient went into shock and had extensive hæmorrhages from the stomach and intestine, and died. Another patient was operated upon for acute pancreatic necrosis twenty-eight hours after admission. There was fat necrosis in the abdominal wall and peritoneum, and stones in the gall-bladder. A cholecystostomy was done and the posterior layer of peritoneum over the pancreas split and drained. The pancreas was soft and mushy. The wound drained for three months and the patient was discharged from the hospital. She was readmitted two weeks later in collapse and died within twenty-four hours. At autopsy stones were found in the common duct, one being in the ampulla of Vater. There was fat necrosis down to the pelvis, scar tissue in the head of the pancreas and a large cyst in the tail. Another patient was operated upon in another hospital for acute pancreatic necrosis with drainage to the pancreas. The patient was admitted to St. Luke's Hospital seven months later with symptoms of vomiting, peripheral neuritis and tetany. The patient suddenly had an attack of acute upper abdominal pain and died within a few hours. Autopsy showed a normal gall-bladder, the pancreas bile stained, the tissue hard and shotty, regional lymph-nodes enlarged and fat necrosis. Another patient was admitted in January, 1931, with cholecystitis and jaundice and refused operation. The patient was readmitted three months later and operated upon for cholelithiasis and common-duct stones. The patient improved immediately after operation, but died on the twenty-first day. Autopsy showed the pancreas bloody and gangrenous. There were also duodenal ulcers and gangrene of the duodenum found at the autopsy on this patient. Another patient was admitted with a diagnosis of chronic cholecystitis. He refused operation, was discharged and readmitted six months later with a history of fever, jaundice and pain. A diagnosis was made of stone in the common duct. At operation, a shrunken gall-bladder which contained seven stones was found. The pancreas was hard, there was no fat necrosis and the common duct appeared to be normal. The

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common duct was drained and the patient died nine days later. At autopsy, the pancreas was firm and swollen and fat necrosis was present. The liver was soft and green, as is usually found in those cases which die from a liver death.

(VII) There were three patients who, after cholecystectomy for cholelithiasis, had epigastric or left hypochondriac pain of varying degrees, which was believed by the operator to have been mild attacks of pancreatitis.

(VIII) Of the whole group of cases, only one showed obvious evidence of infection such as occurs in other parts of the body. This patient was in the medical ward with a diagnosis of portal thrombophlebitis. An exploratory laparotomy was performed, after transfer to the surgical ward, but no operative procedure was done. At autopsy, portal thrombophlebitis and abscesses in the liver and pancreas were found. There were no stones in the gall-bladder or common duct. The pancreatic duct was larger than normal.

(IX) One patient was admitted with a diagnosis of acute cholecystitis and general peritonitis of forty-eight hours' duration. She had an attack, with jaundice, six months previously, and died within twenty-four hours of admission to the hospital without an operation. At autopsy, the whole pancreas was firm, green or red and swollen. The common duct was full of stones. There was fat necrosis in the peritoneum and pleura. This was the only case in which fat necrosis was found to have extended beyond the peritoneal or pelvic cavities or the abdominal wall.

(X) One patient was of particular interest in regard to the question of the value of biliary drainage. She was operated upon after a two-days' history with a pre-operative diagnosis of gall-stones. The pancreas was hard and indurated, there was fat necrosis, and some fluid in the peritoneum. The stones were removed from the gall-bladder and a cholecystectomy was done. The patient's convalescence was uneventful until three weeks after operation, at which time there was a second attack after the bile had stopped draining from the gall-bladder. After re-establishment of the drainage the symptoms disappeared and the patient recovered.

(XI) One patient was operated upon for an appendiceal abscess and developed a fecal fistula two days after operation. Five days after operation the patient developed severe pain with vomiting and was believed to have a perforated gastric ulcer or acute cholecystitis. At a second operation there was a large amount of fat necrosis and a mass in the region of the pancreas, but, because of the large amount of fat in the abdominal cavity, adhesions and thick, short mesocolon, the mass could not be explored or the gall-bladder felt. The patient died in nine hours and no autopsy was done. This was the only case in which an acute pancreatic necrosis appeared to be related to an infection secondary to anything outside of the biliary system, but infection of the biliary system could not be excluded.

(XII) One patient seen previous to the time included in this group developed symptoms of acute pancreatic necrosis followed by a mass in the epigastrium, evidently a pancreatic cyst, refused operation and recovered completely before leaving the hospital. This supplements the patient mentioned above, who had developed three pancreatic cysts after operation and who recovered spontaneously from the second cyst only to have it recur two years later.

(XIII) One patient entered the hospital with a diagnosis of acute cholelithiasis and cholecystitis. Previous to operation, a rectal examination resulted in the finding of a gall-stone in the rectum. At operation a few days later, at which time the gall-bladder containing a second stone was removed, the pancreas was found hard, indurated oedematous and at least twice its normal size.

(XIV) Another patient was operated upon, previous to this group of cases, for an inflammatory tubo-ovarian condition. At operation fat necrosis of the omentum was found, and examination of the pancreas showed it to be hard, indurated and mottled green and red in color. She had shown no symptoms calling attention to the pancreas or biliary system.

The group of cases studied at St. Luke's Hospital numbered thirty-two after excluding all of those cases which were diagnosed as chronic pancreatitis, only those in which an acute lesion was found, either at operation or at autopsy, being considered. Of these, thirty were operated upon. Fifteen died and fifteen recovered. Two patients died without operation, but the diagnosis was confirmed at autopsy. Two cases were diagnosed as acute pancreatic necrosis; two as perforated duodenal ulcer; two as acute intestinal obstruction; and most of them were diagnosed as acute cholecystitis or, when jaundice was present, stone in the common duct. In the latter group the diagnosis was confirmed, the pathological condition of the pancreas being secondary to the biliary lesion. The pancreatic cyst cases were correctly diagnosed.

Comment.—While there is, apparently, an operative mortality of 50 per cent. in these thirty cases, as before stated, a statistical study of mortality and symptomatology cannot be of much value. In many of these cases, which were operated upon with a diagnosis of cholelithiasis and cholecystitis or stone in the common duct, the pancreatic lesion varied enormously, and in some, where the pancreas appeared to be severely damaged, the patients recovered. In most of them, drainage of the biliary system, either by the gall-bladder or the common duct, was instituted. In others, for certain reasons, nothing was done to the biliary tract. Some of them died regardless of the operative procedure. To me, one of the most interesting observations was the fact that in a very considerable number of cases the lesion in the pancreas was described as a thickening in the region of the head of the pancreas, resembling what is usually described as a chronic pancreatitis, but, in practically all of these cases, there were some areas of fat necrosis present. A very considerable percentage of these cases died subsequent to a cholecystostomy or a choledochostomy. An autopsy showed that the mild lesion of the pancreas found at operation had progressed to an acute pancreatic necrosis with extensive destruction of the pancreas. There were other cases in the group of histories studied—which are not included in this series—in which the pathological description of the condition of the pancreas was almost the same as in this group of fatal cases, except for the absence of fat necrosis. These cases were called on the diagnostic cards chronic pancreatitis. If these cases, as most of them recovered, were included in the series reported it would change the mortality rate entirely.

A study of these cases is also of interest as bearing on the question of the etiology and pathology of the various pancreatic lesions. The facts presented may be considered in the light of presumptive evidence, as there is little to be advanced in any direction as conclusive proof. In the vast majority of cases, gall-stones and usually a cholecystitis were present. A few patients had stones in the common duct and in one patient an impacted stone was found at autopsy, and in another patient a stone was found in the rectum which obviously had recently passed through the common duct, and it may be assumed that there was some temporary blocking at the ampulla of Vater.

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In three of the cases there was no evidence of gall-stones, although there was a pancreatic lesion. As pertaining to the lymphatic theory of infection of the pancreas, in only one case was recorded the finding of markedly enlarged glands about the head of the pancreas, and in none of the early cases where a culture was taken was there any evidence of growth on the culture medium (anaërobic cultures were not made).

Several cases demonstrate the fact that various pancreatic lesions occur from which the patients may entirely recover without operative treatment only to have subsequent attacks of greater severity, or develop a cyst. With operative treatment, whatever may have been done, a mild lesion found at operation may progress to a fatal termination. The favorable influence of biliary drainage was, apparently, demonstrated in one case where, when drainage ceased, the symptoms appeared to become worse only to retrogress when drainage was re-established. Whether patients in whom biliary drainage was instituted and subsequently died already had enough damage to their pancreas to cause the pathological condition to progress, or whether interference with the biliary system caused an immediate increase in infection and thus a change in the bile, with diminution of mucin which lessens the bile's irritative action, is difficult to determine. These facts bring into question the value of biliary drainage as a curative procedure. It is demonstrated in this series of cases that even with a severe pancreatic lesion the patient may get well without an operation and that certain other patients who have an operation for a mild lesion will die, due to a progressive extension of the pathological process. It is also demonstrated that certain severe cases will die without operation, as shown by two of this series which were proved by autopsy. It is further demonstrated that cysts of the pancreas, which vary from a small, fibrosed area containing a cheese-like material, to a cyst containing a quart of turbid, yellow fluid, may form in from seventeen days to several months after an acute lesion and may then require operation or may spontaneously disappear entirely or may become calcified.

The value of a cholecystectomy as a curative therapeutic procedure, while not disproved, at least is made dubious by the history of the patient who developed a pancreatic cyst which progressed and increased in size two years after a cholecystectomy was done, but in this instance the damage to the pancreas had already occurred and there was no new acute attack. The possible relationship to an appendicular infection, which frequently is mentioned but seldom proved, might be instanced in considering the patient who, five days after an operation for an appendiceal abscess, developed an acute pancreatic necrosis, but, in this case, the gall-bladder could not be examined.

In only one case was there infection such as is found elsewhere in the body. This case, which is not included in the series of acute pancreatic necrosis as it obviously falls under a different heading, was the one having multiple abscesses in the pancreas and liver and where the etiology was a portal thrombophlebitis.

There was fat necrosis, in varying degrees, present in all of these cases

except one. It varied from small, minute areas in the fat or omentum about the pancreas, to more extensive necrosis throughout the peritoneal fat. In two patients, it extended to the pelvis; in one, to the abdominal wall; and at autopsy on a patient who died without operation, it was found in the lung and pleura. At autopsy, on a case operated upon by me previous to this series—when it was considered proper surgery to drain into the broken-down pancreas—it was found that the pancreatic leakage had obviously caused extension of the fat necrosis all through the retroperitoneal tissues down into the pelvis. This, in addition to other reasons, seems to me to be sufficient proof that the old method of pancreatic drainage was bad surgery.

An attempt to formulate a symptomatology or diagnostic criteriae which would include all cases of acute pancreatic necrosis would be futile unless they were divided into the two main groups into which such cases fall. These are—first, the occurrence of a major upper abdominal catastrophe, in which the differential diagnosis must be made from a perforated duodenal or gastric ulcer, an acute intestinal obstruction or a rapidly developing peritonitis. The second group are those in which symptoms of an acute biliary lesion predominate, with the pancreatic pathology as a secondary development. Even this grouping would omit the occasional case where the lesion is mild and without definite symptoms.

In the first group, if there is severe upper abdominal pain, radiating to the back, an acute pancreatic necrosis must be considered. In a very considerable number of cases a history of previous attacks, suggesting biliary disease, may be elicited from friends and relatives if the patient is too sick to give a history. A flat X-ray film to help rule out a perforation or to demonstrate localized distended intestine may be of negative value, as is the loss of liver dulness. A patient with early pancreatic necrosis usually writhes about in bed because of pain. With a perforation he lies quietly because of peritoneal irritation. In the former, at the beginning of the attack, there is absence of rigidity. Later, rigidity appears with the appearance of "beef broth exude" and peritoneal irritation. Vomiting, pulse rate, temperature, urine examination and blood count might be those of any acute abdominal lesion, but not definitely diagnostic, except that the blood count might differentiate an intestinal obstruction from an inflammatory or necrotic lesion. A high blood-sugar and high diastase values in the blood or urine are also of differential diagnostic value. In the acute fulminating cases, X-ray examination with a barium meal is impractical but in the more slowly developing cases, with the slow development of an enlargement of the head of the pancreas or a cyst, this condition may frequently be demonstrated.

In the group of cases where biliary symptoms predominate, either as jaundice or as signs of an acute cholecystitis, the fact that the pancreatic damage, from a slight to a very severe degree, may occur in a small but very definite percentage of cases must be kept in mind. This was well demonstrated in the group of cases reviewed and perhaps in patients falling into this classification, who complain of pain and tenderness in the epigastrium

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and left hypochondrium, in addition to their biliary symptoms, a high or increasing blood-sugar or diastase values in the blood and urine might be an indication of progressive pancreatic injury. While it is stated that the primary influx into the pancreatic duct causes the immediate maximum damage, the examination of the above recorded cases would appear to demonstrate that the irritating factor may be repeated. This, it would seem, has an important bearing on the operative treatment. And, while it is accepted that an acute pancreatic necrosis is an uncommon sequel to a biliary infection, it is not unusual to find some thickening in the head of the pancreas accompanying gall-bladder or common-duct pathology. The small number of autopsies or secondary operations in this series of cases has demonstrated that this pancreatic lesion may progress. It is my belief that this should be considered in the application of a universal rule for delay in all acute gall-bladder cases.

The surgical management of pancreatic necrosis must depend on whether one is dealing with an acute fulminating case or one in which the symptoms are due mainly to disease of the biliary system. The patient with the acute fulminating lesion is in shock and is a very bad operative risk. One such patient, in the series examined, died on the table. Operation should be postponed until suitable treatment for the shock, especially with glucose intravenously and hyperdermatically, has been instituted. Occasionally, such acutely ill patients are operated upon when the exact diagnosis cannot be determined, especially if a perforation is believed to exist.

Any standard operative procedure would be difficult to formulate. Many of the more severe lesions will cause death, either with or without operation. When extensive damage of the pancreas has occurred, it is necessary to drain down to the pancreas. At operation it may be impossible to tell how far this destruction may go. Cases are on record where practically the whole pancreas has been extruded as a slough. One such case was reported recently, with recovery of the patient. Therefore it is necessary to provide for the possibility of this occurrence, as well as to allow for the escape of split proteid products which are of a toxic nature. Such drainage should be provided for by a rubber dam. A tube should not be used. Patients may die of late secondary hæmorrhage from erosion of the large vessels in the mesocolon or about the pancreas. This would be more apt to ensue if rubber tubes were used as they may cause pressure necrosis. The question of biliary drainage depends upon the acceptance of the theory of biliary influx into the pancreas as an etiological factor. The evidence seems to strongly favor this. If one accepts the theory that the maximum damage is effected by the primary influx of changed bile, such drainage would, theoretically, be ineffectual, but the evidence of the group of cases examined would seem to prove that this influx can be repeated. Consequently, drainage should be instituted. This is most easily effected by cholecystostomy. If there are stones in the common duct these should be removed, but this is not always effectual, as is amply proved by the progression and recurrence of lesions after institution of biliary drain-

age. An extensive operation cannot be done when the patient is very ill. Theoretically, one should establish the fact that the common duct is patent into the duodenum, but probing of the common duct may cause swelling and œdema from traumatism at the ampulla of Vater, and thus increase the possibility of reflux of bile. This leaves the matter of operative procedure one that should be determined largely by the pathological condition found. It has been suggested that a cholecystectomy would be the ideal procedure, first by the removal of the focus of infection and thus the elimination of one etiological factor, that is, the change in the bile with its increased bile salts, which occurs with infection, and second by causing dilatation and relaxation of the sphincter of Oddie, which occurs after cholecystectomy. But, before this dilatation and relaxation occur, unless drainage is also instituted, pressure in the common duct is increased, which would more likely result in reflux into the pancreatic duct, if anatomical conditions were such as to allow this. Furthermore, the less that is done to such a seriously ill patient the better the prospect of recovery.

It might be expected that with the extensive damage to the pancreas, there would be more evidence of failure of its function, as shown by elevation of the blood-sugar, but it is surprising in many instances how little there is of this symptom. In some cases, however, there is sufficient impairment of function to make the use of insulin of considerable value in the post-operative treatment.

The recurrence of attacks, often of a severe or even fatal nature, after recovery from an operation for acute pancreatic necrosis where biliary drainage has been instituted, would seem to indicate that it would be good surgery to remove the gall-bladder in these patients as a prophylactic against further pancreatic damage after their recovery from the primary attack.

BLOOD CYST OF THE SPLEEN

(INTRACAPSULAR RUPTURE)

By FREDERIC N. G. STARR, F.R.C.S. (CAN.)

OF TORONTO, ONTARIO

IN JULY, 1928, a boy aged ten years was brought to my consulting-room. His mother had noticed him "standing crooked." He was pale and undernourished but very active. He did not stand up straight but canted over to the left.

Upon examination there was discovered a large mass in the left upper abdomen, the lower border of which was smooth and rounded, the notch not palpable, and extended



FIG. 1.—Cyst of spleen with portion of wall removed to show inner lining.
(One-half actual size.)

to the level of the umbilicus. There was dullness on percussion up to the level of the seventh rib on the left side in the mammary line. The lump moved with respiration. Upon turning him on his right side, the tumor moved to the mid-line. In this position I could elicit fluctuation. He weighed seventy-five pounds.

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A pyelogram was made and the kidney was found to be normal but displaced downward. The blood smear was normal, the white count only 7,000.

There was a history that two years previously he was playing hockey in the school yard and when dodging another boy he struck the left side of his abdomen against a post. He was "knocked out" for a few minutes. After that, not feeling like any more hockey, he went home. He felt seedy and lay about the house for a few days; then he returned to school and carried on as before, taking part in the play with the other boys, and gradually getting into shape so that one day he might qualify for a post on one of the so-called American hockey teams.

He again presented himself in November and the tumor was larger. I advised operation. Preparatory to this, on November 26, 1928, he was given a blood transfusion. On the following morning the abdomen was opened through a left rectus incision. Some adhesions between the left lobe of the liver and the splenic tumor were encountered and



FIG. 2.—Section through cyst-wall showing splenic capsule, remnants of splenic tissue and dense hyalinized cyst-wall proper. (X100.)

divided, and some adhesions to the posterior parietal peritoneum were also divided, and the tumor delivered. The pedicle was then clamped, the spleen removed and the pedicle sutured. Other bleeding points were secured and ligatured or sutured. The boy made an uninterrupted recovery, returning home on the seventeenth day.

I saw him again in the following April. He was very well, eating, sleeping, and playing like a normal child, and had gained nine pounds in weight. His health has continued to be excellent.

The inference is that when he struck his left side two years previously he sustained an intracapsular rupture of the spleen, which accounted for this ultimately becoming a blood cyst containing degenerated blood. It is known that such cysts occasionally occur from an infarct in the spleen, but in this case there was no history of a previous illness up to the time he met with injury. I have been able to find but few references to this type of splenic tumor, but several cases have been reported.

Dr. W. L. Robinson, the pathologist, reports upon the specimen as follows:

The spleen was moderately enlarged, measuring 18 by 13.5 by 5 centimetres.

BLOOD CYST OF SPLEEN

The capsular surface was smooth, tense, and glistening. The organ had been almost entirely transformed into a large thin-walled cystic structure and was quite fluctuant on external palpation. On opening the cyst about one quart of rather thick reddish-brown fluid material flowed out freely. The greater portion of the wall measured about two millimetres in thickness, other portions of it being extremely thin and semitranslucent. It was lined by soft masses of partially coagulated blood. On removing these clots the wall presented a smooth, glistening but coarsely trabeculated appearance.

Microscopical sections taken through the wall of the cyst show the latter to be made up of a thick layer of mature fibrous connective tissue rich in collagen. Much of this is of a homogeneous and relatively acellular appearance. Adhering to the inner lining (Fig. 1) are masses of platelets, fibrin and red blood-cells. Toward the inner margin are numbers of endothelial cells laden with hemosiderin pigment, together with considerable amounts of recently extravasated blood. A few scattered lymphocytes are observed between the connective-tissue bundles. In the more dense portions of the wall are focal deposits of iron and calcium. Between the capsule (Fig. 2) of the organ and the fibrous wall of the cyst very small remnants of splenic tissue were found.

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SURGICAL JUDGMENT IN THE APPROACH TO THE ACUTE ABDOMEN

BY LE GRAND GUERRY, M.D.

OF COLUMBIA, S. C.

WE ARE constantly drawing this distinction between an operator and a surgeon: defining an operator as one who is concerned primarily with problems of method and technic, or, as it were, the ritual of surgery. Such a person is not greatly concerned with the broad fundamental principles of medicine that underlie the practice of good surgery.

On the other hand, we like to think of a surgeon as one who has been broadly educated, who possesses philosophical background, who is more concerned with principles than with the technic of method, who understands that the basis of good surgery is good medicine, who has mental capacity and grasp to deal with the spectral doubts that lie outside of the operating room, and who understands when and where to operate as well as how to operate.

This is just another way of saying that we intend to discuss for the few moments at our disposal the subtle problem of judgment; specifically, surgical judgment. Just at this point it may be well to define judgment in the language of Webster: "The word judgment has its derivation from the Latin word *Judicare* and is defined as 'The act of judging; the operation of the mind, involving comparison and discrimination, by which a knowledge of moral qualities, intellectual concepts, logical propositions, or material facts, is obtained. The power or faculty of performing such operations when unqualified, the faculty of judging or deciding rightly, justly, or wisely, good sense.'"

To my thinking it is impossible to discuss properly the approach to the acute abdomen without a consideration of surgical judgment since the two things are well-nigh synonymous terms. The reason for this is not far to seek. The mistakes of surgical judgment in handling the great crises of the acute abdomen can be quickly turned into fatalities. The fate of these cases depends, not primarily on a technic and method of operation, but are indissolubly connected with clear, precise, discriminating judgment.

The surgeon who properly correlates his facts, wisely interprets them, who uses the clearest judgment in the application of these facts to the individual case, will always have the best results. This is a principle that is germane to the whole range of human thought and action. It is true in business; it is true in law; it is true in general medicine; it is true in surgery.

This is the reason, certainly one of the reasons, why problems of judgment so vastly outweigh in importance methods of technical performance.

Sir Frederick Treves, one of the keenest and most philosophical minds

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in the field of surgery, has given us this aphorism: "Shakiness of the hand may be some bar to the successful performance of an operation, but he of a shaky mind is hopeless."

To illustrate: An ordinary supravaginal hysterectomy for an uncomplicated uterine fibroid tumor in an otherwise sound and healthy woman does not call for the exercise of any special amount of judgment; it is a conventional operation, with ample time not only to prepare the patient, but to fix and determine the conditions under which the operation shall be done. It becomes at once obvious in such a case that method of operating and technic of performance take the position of primary importance.

How vastly different is the problem, however, in the case of a man with a bullet wound through his abdomen. When you see him for the first time he is in profound shock, with a feeble rapid pulse, cold clammy leaky skin, subnormal temperature, cyanosis, air hunger, and probably intraperitoneal hæmorrhage. The threshold of his vitality and resistance has been forced down to the lowest possible level; well-nigh anything done to him would be enough to push him over.

How are you going to handle such a case? Take him to the operating room and operate immediately? I think not. For this situation imposes on us not only difficulties of handicraftsmanship, but the far weightier problem of when to interfere. Surely the patient would be better off to take sufficient time to improve his general condition. Namely: by getting him warm, by giving him sufficient morphine to relieve his pain, by raising his fluid level, by giving him time to react from the primary shock of the injury, by blood transfusion, *etc.*

One of the most serious problems in connection with the acute abdomen, particularly so and always present in the matter of penetrating wounds, is the question of hæmorrhage. It is serious enough to be responsible for a large number of deaths from this source. Many of these patients die from hæmorrhage long before the stage of peritonitis has been reached. Our position about the surgical handling of such cases may be stated as follows: We believe it to be a great mistake to take these patients with penetrating, perforating bullet wounds of the abdomen that arrive in a condition of profound shock, with or without hæmorrhage, rush them to the operating room and operate immediately. If you do so you are inviting disaster and an excessively high mortality. Specifically as regards the problem of hæmorrhage we must remember that in the presence of traumatic shock it takes comparatively little loss of blood to produce a profound circulatory disturbance.

Often we have had this experience: In cases of perforating wounds of the abdomen with hæmorrhage, we have operated on and repaired ten or twelve perforations, practically emptied the abdomen of blood and completed the operation without finding the source of hæmorrhage. An irregular tear in a small vessel coupled with a profound drop in blood-pressure permits thrombosis of the vessels thereby controlling the hæmorrhage before the

operation is undertaken. This is one of the main reasons why we never operate with precipitate haste. On the other hand, proponents of immediate interference will occasionally take part in the dramatic episode of saving a life by finding and controlling the bleeding from a larger vessel. In so doing, however, they will sacrifice ten lives for the purpose of saving one. We believe this to be bad surgery.

Let me repeat, as indicated above, much of the time through the operation of natural forces the bleeding will already have stopped.

And remember this: that even in the presence of a perforated intestine, it takes time to develop a spreading peritonitis. There may be immediate local soiling but not a true peritonitis. This takes time to develop; several hours of time at that. In many cases you have ten or fifteen hours in which operation can be deferred with advantage.

Some years ago I published a paper on "Penetrating Gunshot Wounds of the Abdomen" in which there were reported twenty-seven cases with a mortality of about 10 per cent. I am perfectly convinced that a number of these cases were saved by taking the necessary time to improve the patient's condition before operating.

To illustrate: A woman, aged thirty-seven years, with an infected gall-bladder with stones, was operated on December 4, 1931. Operation was the conventional cholecystectomy which was readily accomplished without any undue difficulty. She left the operating table in excellent condition. There was no problem up to this point to tax one's judgment or surgical resource. What an amazing difference to find the patient on the same afternoon about 5 o'clock *inarticulo-mortis* from an intra-abdominal hæmorrhage. Surely, here we were in the presence of a real emergency. The customary thing to do under such circumstances would be to give the patient an anæsthetic, reopen the abdomen, and stop the hæmorrhage.

The patient was carried to the operating room in her bed. I was convinced that the ligature on the cystic artery had slipped and that this was the source of the hæmorrhage. However, she was so nearly dead that it seemed to me, and to my associates, that any attempt to open her abdomen would be immediately fatal. She was given a blood transfusion of about 500 cc. Her condition improved but very little. After waiting several hours, expecting her death at any moment, we gave her another blood transfusion of 500 cc. To this transfusion she made definite, though slight, improvement. Even up to this point her condition was so precarious that we were afraid to make any formal effort at stopping the hæmorrhage. Early the next morning we could be reasonably certain, through observation of the gauze drainage and cutting of one suture next to the drain, that she had had no further bleeding.

To make a long story short, this patient was never reoperated on. At this time she is perfectly well, and we believe that her recovery was due to the fact that she was simply "waited out" and that no operative effort was made to control the bleeding from the cystic artery.

You can see the point that I am trying to make: The problem in the first instance was the simple problem of doing a conventional cholecystectomy. Faced in the second instance with immediate death from a surgical calamity, the great problem involved was one of discriminating surgical judgment, and on the correctness of this judgment hinged the matter of life and death.

This much we absolutely know: that the patient is today alive and well

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and no secondary operation was performed for the relief of her hæmorrhage.

An old axiom of medicine and surgery is to give the patient every possible chance. It is a very easy thing, in the presence of such an emergency as outlined above, to deprive the patient of her only chance.

The physician or surgeon who learns properly to evaluate the "*vis naturae medicatrix*" has attained the beginning of wisdom. There is scarcely any limit to her capacity to help.

We could continue indefinitely with similar illustrations to prove that in the handling of the acute abdomen this thing of discriminating judgment, wrought out of a background of clinical experience, is the great desideratum.

We have only time to hint at the difference of the problem involved in an unruptured appendix on the one hand and a perforated appendix with peritonitis on the other; or a simple cholecystitis as against a perforated gall-bladder with peritonitis; or a simple cyst of the thyroid as against an intensely toxic hyperplastic thyroid; or a simple duodenal ulcer as against a perforating duodenal ulcer. And so on we could furnish illustrative cases to the very end of the chapter.

After an experience of a bit better than thirty years, there is no problem in surgery about which I have altered my attitude more thoroughly than in the matter of the acute abdomen. This business of rushing into the acute abdomen with precipitate haste, simply because it is acute, is all wrong and carries with it its own label of incompetency. In many, many cases the urgent thing to do in the acute abdomen is to leave the patient to the unimpeded efforts of nature. The operator simply has before him the problem of operative interference, while the surgeon possessed of discriminating judgment will be, or should be, able to separate the cases that need prompt intervention from those whose chance for life would be conserved by reasonable delay.

The surgeon who puts aside sound judgment and precise anatomical knowledge for the age-old axiom of "cut and tie" will surely "reap the reward of his labors."

Axioms.—May we now take a more intimate view of our subject.

(1) Don't be in too great haste to operate. Nearly always there is ample time, not only to be reasonably sure of your position, but to improve the patient's general condition. The surgeon should control the initiative and dictate the terms under which the battle is to be fought. The easiest way to make a fatal error in judgment is to be hurried.

(2) Don't delay operating unduly in the hope of making a complete diagnosis. Certainly this is true in the presence of the acute abdomen. A complete diagnosis much of the time is impossible. I do not worry too much nowadays about the question of diagnosis in the presence of a surgical abdomen. What gives me endless concern is this: Are the indications sufficiently clear for going in? There is ample time for complete diagnosis when the abdomen is opened. Understand me here; I am not belittling diag-

nosis, for it is one of our sheet anchors. We must keep a clear perspective and properly evaluate the patient's condition.

(3) Don't, please don't, continue the vicious practice of using purgatives in the presence of acute lesions of the abdominal cavity. This is a trite statement, and very much has been written about it; however, patients continue to come in day in and day out in which this fundamental point has been disregarded.

Many of our ablest surgeons contend that there is no such thing as a diffuse peritonitis following a perforated appendicitis in which purgative medicines have not been used. This may not be literally true but there is a vast amount of truth in the statement. Purgation is the very badge of ignorance so far as the acute abdomen is concerned. Purgation in the presence of an acute intraperitoneal infection may readily be fatal.

(4) Don't give morphine until the diagnosis has been made or until you are reasonably certain that operation is to be done. It will surely mask the symptoms and lull you into a false sense of security. The truth of the matter is this; morphine puts two people to sleep; the patient on the one hand and the doctor on the other. Also remember that if it takes more than one-half grain of morphine to relieve an attack of appendicitis it likely means that you are not dealing with appendicitis but probably with stones in the gall-bladder, kidney or ureter.

(5) Don't fail in the vitally important matter of proper drainage. When once decision is made for operation, particularly in the presence of intraperitoneal suppuration, we must be thorough and radical in our handling of the pathological process. Adequate drainage is one of the essential elements of success. The very popular statement of "when in doubt don't drain" may be witty after a fashion, but it is altogether vicious as a surgical principle. I am afraid of pus in the abdomen. It matters not what its origin or what the amount. If we handle intra-abdominal suppuration carelessly we will come to know the meaning of the appellation "trickster."

(6) Don't fail to grasp the difference between a contaminated wound and an infected wound. I mean precisely this: In the presence of intraperitoneal suppuration, notably in reference to appendiceal abscess where there is obliged to be gross soiling of the tissues, if the technic and intraperitoneal toilet has been correct, drainage complete and thorough, closure of the wound properly handled, one can be practically sure of primary union in 85 per cent. to 90 per cent. of the cases, and a suppurative appendix can be well-nigh turned into a clean case so far as morbidity and confinement to the hospital are concerned. Such a wound we think of as a contaminated wound. If, on the other hand, the same identical wound is sewed up tight, hermetically sealed as it were, the wound will break down in 90 per cent. of the cases with extensive suppuration. In this instance the wound is viewed as an infected wound. It is of basic surgical importance to remember that the pus that does the damage is the pus under pressure.

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(7) Don't fail to remember that nothing so mars the convalescence of a patient or compromises more directly the result of an operation than wound infection. A simple but rigid, aseptic technic, gentleness and respect for the tissues in the manner of handling them, are matters of primary importance. The size, the extent, the location of the incision, the readiness with which the incision gives the surgeon access to and control of the field of operation, constitute the epitome of operative surgery.

Knowing what not to do is just as important as knowing what to do. This is especially true in the presence of the acute abdomen, for the surgeon is a good surgeon who knows when he is doing harm and will quit.

I close by reminding you that the father of medicine has bequeathed to us this sage axiom: "Life is short; art is long; experience fallacious; judgment difficult."

CHOKED LEG

By JOHN EDWARD JENNINGS, M.D.

OF BROOKLYN, NEW YORK

IN 1922 AND 1923, interested by the work of Leriche and his reports of it, I, with many others at about that time, attempted to apply his operation of peri-arterial sympathectomy to the treatment of various forms of threatened gangrene of the toes and feet.

I have reported some of these experiences elsewhere and will allude to them here for only one purpose. Quite as much by accident as by design, at first I found it convenient to do the operation in Hunter's canal and I found that I was obtaining better results than my fellows who were operating on the artery higher up. At first we attributed this to the somewhat different technic of the arterial stripping which was measured in distance and thorough in depth, but as we went on, the anatomical findings in Hunter's canal suggested a train of thought and initiated an inquiry which has seemed of some interest.

"Hunter's canal, or the Adductor canal" [canalis adductorius Hunteri] says Gray, "is the aponeurotic space in the middle third of the thigh, extending from the apex of Scarpa's triangle to the femoral opening in the adductor mangus muscle. It is bounded externally by the vastus internus, internally by the adductors longus and magnus and is covered in by a strong aponeurosis which extends transversely from the femoral vessels to the adductor longus and magnus, lying on which aponeurosis is the sartorius muscle. It contains the femoral artery and vein enclosed in their own sheath of areolar tissue, the vein being behind and on the outer side of the artery and the internal or long saphenous nerve lying at first on the outer side and then in front of the vessels."

It has been interesting to trace the use of Hunter's name to the adductor canal in which he first tied the femoral artery for popliteal aneurism.

"The first operation of this kind ever done was performed on a coachman by Mr. Hunter in St. George's Hospital December, 1785. An incision was made on the anterior and inner part of the thigh, rather below its middle, which wound was continued obliquely across the inner edge of the sartorius muscle and made longer in order to facilitate doing whatever might be necessary. The fascia covering the artery was then laid bare for about three inches, after which the vessel itself could be felt. A cut about an inch long was then made through the fascia along the side of the artery and the fascia dissected off. Thus the vessels were exposed, *etc.*, *etc.*"

It is evident that this ligation was done in the adductor canal which is not here so discussed nor is the name of the great surgeon mentioned—*anatomically*. Scarpa later advised tying the artery higher up above the canal and his opinion has prevailed.

Then Hunter and his immediate contemporaries did not refer to the adductor canal in his name and the first reference I have been able to find is in "Holmes' System of Surgery," 1860.

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One suspects the teachers of operative surgery on the cadaver rather than the anatomists of this; at any rate it is well settled in British anatomical literature now. It defines a well-recognized space and its repetition serves to remind us of a noble name in surgery. Let it remain.

As we continued to perform sympathectomy on the femoral artery in the canal of Hunter we noted in some cases that the space about the vessels was filled with loose areolar tissues from which the artery was easily separated but that in others this bed was frozen by old inflammation and that it required time and effort to free the vessels which was not always accomplished without damage to small branches of the artery or to branches of the closely adjacent vein and in a few cases we found an increased tension within the canal which was quite evidently relieved when its roof was laid open. It seemed that the canal was the site of a perivascular lymphangitis usually in this group of cases of long standing and we wondered what, if any, relation this may have had to an arterial spasm at or below this point.

This led to the suspicion of the possibly important place that this area holds in the distribution of the blood and lymph circulation of the leg. It seems evident that the arterial blood supplying the leg, save for the normally insignificant anastomotic circulation around the knee, passes through this canal. The same is true of the deep venous return and also of the deep lymphatic vessels.

A middle-aged man, who had suffered from osteomyelitis of the right femur for many years, had been operated on a number of times and had always had several discharging sinuses, found the characteristic swelling and brawny œdema of his leg growing more and more painful and disabling. Then two ulcers appeared on either side of the lower third of the leg. These ulcers healed or nearly healed when he was confined to bed but immediately re-opened when he resumed activity. He finally asked for amputation and this was done through the upper third of the thigh. Hunter's canal, with its contents and the surrounding muscles was excised from the amputated limb and studied. The perivascular lymph bearing areolar tissue was found œdematous, indurated, the seat of round-cell infiltration densely packing the canal and evidently compressing the artery and vein and blocking the lymph channels in it. This block must, it would seem, have varied with posture and with greater or less venous pressure. Perhaps to some extent with the rise and fall of pressure on the artery and not improbably with intermittent inflammation and congestion in the lymph structures around the vessels.

This led to the question in our minds—is it possible that cases of phlebitis of the femoral vein, with the attendant swelling of the leg, may depend for their early exhibition of this sign upon a lymph block in this space, and might an old case, with continued swelling of the leg and pain on standing or walking, be benefited by opening widely the roof of the canal with relief of tension?

An opportunity to test this matter soon presented itself. W. S., thirty-nine, a clergy-

man, gave the following history. He had appendicitis followed by pneumonia and later by phlebitis of the right leg in 1917. He was ill for six months after which he recovered and had been able to perform his duties, but his leg had always been swollen; had always ached on moderate exertion and if he attempted to use it long the pain became very severe. He had been somewhat benefited by the use of an elastic stocking. Eighteen months ago a small, irritable ulcer formed just above the malleolus and had been open a good deal of the time since. It is now about one centimetre in diameter, surrounded by an area of brown induration six centimetres in width. There are no superficial varices evident. The leg is 3 inches larger than its fellow at the calf. Is not tender, does not pit on pressure. The other leg is normal and all other findings are negative. *Operation.* An incision eight inches long along the lower third of the inner surface of the right thigh following the course of the sartorius muscle was made. The sartorius sheath was opened, the muscle retracted and Hunter's canal freely opened from end to end. The vessels were tightly constricted at the lower third of the canal, the vein was almost entirely obliterated in the canal, dilated above and varicose below. The vessels were freed from the constricting roof of the canal after which they expanded. The ulcer was undermined through a small slit an inch above it. The skin incision was closed with interrupted sutures of silkworm gut. Convalescence was uneventful. His ulcer healed while he was in bed. His pain, to his surprise, did not return when he began to walk and he reports, a year after his operation, that he is completely well, able to stand all day with no ache or swelling of the leg, which is one inch larger than the other.

Encouraged by this experience, a second presented itself. Mrs. V, forty, white, widow, four children. July 9, 1932. About four years ago an acute attack of abdominal pain which was considered salpingitis. At this time she had a double phlebitis which never completely subsided. This has gradually been getting worse, especially on the left side, so that she is now completely incapacitated. Both legs are swollen even after rest in bed for two weeks. The left leg measured $19\frac{1}{2}$ inches, the right 15 inches. The left extremity was somewhat tender along the course of the femoral vessels. There was some tenderness in the right fornix. The cervix showed an old laceration. The uterus was in normal position and of normal size. *Operation.* An incision along the inner lower third of the left thigh following the medial border of the sartorius was made. The muscle sheath was opened and the roof of Hunter's canal exposed. The femoral artery was exposed and lifted from dense inflammatory tissue which surrounded it, wounding the almost obliterated vein and artery. The bleeding was controlled by fine silk sutures. The canal was opened widely from the popliteal space to its upper limit and the fascia, and skin closed. Her convalescence was uneventful. She went home much improved but this was of short duration and she returned to the hospital for observation. Her leg became much smaller (from $17\frac{1}{2}$ to 14 inches in circumference) while in bed. Pain continued but was not so severe. Pelvic examination showed tenderness in both fornices more marked on the right. No masses. Uterus somewhat large and in first-degree retroversion. We decided to explore the pelvis and if possible to do a left lumbar ganglionectomy. This was done with difficulty and distress. The pelvis was found free and clean but there was great dilatation of the right pampiniform plexus. Obliteration of the external iliac vein diminished the lumen of the common iliac. Incision too low for good exposure, increased in length. Vein entering cava deep behind the aorta impaired in dissecting sympathetic. Clamped. Trouble in tying, free bleeding, four clamps applied, two Keith's and two Kochers left in. Apparently a branch of the azygos dilated to compensate for the obliteration of the iliac. Her post-operative course was painful. The clamps were loosened on the fourth day and removed one at a time on the three succeeding days, after which her pain which had been diffuse over the left thigh and buttocks, with marked hyperæsthesia, subsided slowly. In about three weeks after her operation she was able to walk without pain and went home. She returned in a month steadily improving and with less than an inch of swelling of the leg after walking about the house. Her pain was almost gone.

CHOKED LEG

A month after this, however, she returned with increased pain which came on when she walked a block and became so severe that two blocks was all she could manage. She would then rest and allow her pain to subside when she could again walk two blocks more. She complained of pain in her leg, reflected down from a spot below and to the outer side of the knee and of sharp shooting pain radiating from a point in the lower end of the scar on the upper and inner side of the thigh.

She remained in the hospital for six weeks when she went home again improved but she still complained of pain on any prolonged exertion, being able to walk about two blocks at a time when she has to sit down and rest. The leg is swollen on exertion but not so much as before. The pain is different but still quite severe at times. It was decided to re-explore the femoral vein and artery. The scar on the left thigh, six inches long, was removed and dissection carried down to the femoral vessels. The artery was found stenosed, practically obliterated at the site of previous injury. The artery was cut between ligatures. The vein lying behind it was thickened, adherent and contained little blood and about a third of its normal lumen. One and a half inches of the vein was removed between ligatures and the muscle and skin closed. Following this third operation her improvement has been steady with two interruptions in which pain and tenderness have arisen along the lower part of the femoral and popliteal veins, apparent extensions of a localized phlebitis. In another similar case, I should excise the femoral over a much larger area.

The case is, however, very suggestive and I think indicates the further exploration in Hunter's canal of obstinate cases of femoral phlebitis. Sections of the vein removed showed thrombosis with organization and recanalization of the vessels and marked perineural fibrosis.

A study of the literature finds little save several articles by Rene Leriche, which, however, deserve somewhat extensive abstract. He says phlebitis of the lower extremity is common but there is little light on the late sequelae. How many cases recover completely? What trouble remains in the mild cases which are so frequent as a post-operative complication? It is also true that we do not know what is the pathological anatomy of the syndrome we call phlebitis. An operative case, twelve days or so after, has a pain in the calf. Soon he complains of pain in Scarpa's triangle and along the vein oedema appears. The limb is immobilized. In a few days he is well. After he gets on his feet he will notice for some time a little oedema in the evening, then all is over. What happened? Was there really an inflammation of the vein wall and an obliterating thrombosis? If there was a thrombosis where was the clot? How extensive was it? Did it become organized? What is the mechanism of the oedema in these cases and does it disappear so quickly? Frankly we know nothing of all this and yet these cases are so common that we ought to know more.

He describes a group of cases of chronic oedema of the lower extremity in middle-aged patients. The oedema is rather hard, very different, however, from the oedema of elephantiasis; often painful; deep red at rest; cyanotic in the erect posture; occasionally small ulcerations on the leg. He tried, in a few cases, peri-arterial sympathectomy in Scarpa's triangle without avail.

In another group of cases he found external iliac obliteration partial or complete due to old pelvic inflammation and describes operations freeing the constricted iliac veins. His cases were promptly benefited by the abdominal surgery but recurred. In one case of obliterated iliac vein on which lay an inflamed ovary, he resected the obliterated vein from the bifurcation to the femoral ring performing also a peri-arterial sympathectomy with complete recovery. He says the oedema was evidently removed by the resection of the vein and not by the removal of the ovary nor by the sympathectomy. Resection of an obliterated external iliac vein has no effect on the hydraulics of the leg. It must then have acted in suppressing a permanent cause of vascular reflexes causation of oedema.

Masson examined tissue removed (iliac vein) and found no trace of lymphatics but in a mass of connective tissue a large number of sympathetic fibrils and ganglion cells.

He even reported the existence of a sort of para-ganglion found by interlacing sympathetic fibrils away which were tactile corpuscles and groups of large cells with vacuolated protoplasm and fine granules with the appearance of chromofine substance. He draws two conclusions—the lymphatics are not to blame. The sympathetic elements are certainly affected by the process of sclerosis and one may conclude, sympathetic irritation is probably a contributing cause of the œdema.

He continues in the major phlebitis of the femoral vein which changes the vein into a fibrous cord, the later appearance of varices betrays the absence of permeability of the principal drainage route but when no venous trouble persists it would seem that the phlebitis has remained localized. The pain at its beginning may be due to spasm like that which follows the injection of a caustic. This may explain the occasional efficacy of leeches, *etc.* This constriction may be the cause of the œdema obstructing venous return. Anyway, when the spasm relents, as soon as circulatory equilibrium is re-established, the œdema disappears and the patient is exactly in the condition of one who has, at one point of his femoral vein, a well-tolerated ligature. However, after some time some of these patients complain of great fatigability or pain of distressing cramps and of a little œdema. What can be done for them in an operative way?

In two cases he discovered a femoral vein from Scarpa's triangle to Hunter's canal. It was found small, flattened, hardly filled with a much reduced circulation. He concluded that there was somewhere lower down a complete obliteration and that the vein now only functioned as a secondary collateral. Not finding the obstruction he tied the vein, removed a specimen and did a femoral sympathectomy.

In another case he says he should have carried his exploration to the popliteal space if time had permitted and may have to for complete relief. In this case he merely freed the vein.

In a series of cases in which Hunter's canal was exposed for peri-arterial sympathectomy perivascular changes were found grossly indicative of long-standing chronic inflammation.

In two cases of painful œdema following femoral phlebitis, a condition for which choked leg seems a convenient term, the vein was explored in Hunter's canal and thickening of its walls with partial obliteration and varicosity were found. In one of these cases freeing the roof of the canal and liberation of the vein brought prompt and lasting—one year—relief. The other was followed by temporary relief after which an abdominal sympathectomy was done with slight improvement after which re-exploration of Hunter's canal was done and the vein tied and cut but not resected. This has been followed by period of complete relief and by two periods of localized pain and tenderness over the lower portion of the femoral vein. The swelling has been reduced from nineteen inches to fifteen inches and is stationary.

It is suggested that in cases of chronic œdema of the leg following phlebitis, Hunter's canal be widely opened and explored and that if the vein be found extensively thickened or varicose or both, that it be resected for its entire length.

The pathological anatomy of these two cases seems clear. A partially obliterated, chronically inflamed and varicose vein, the site of intermittent back pressure in the closed space of the canal of Hunter. In one case the release of this closed space was adequate, in the other it was not, nor was ligation and section of the vein entirely efficient.

PRE-OPERATIVE IRRADIATION IN CASES OF CANCER OF THE BREAST WITH AND WITHOUT BIOPSY

BY JOSEPH COLT BLOODGOOD, M.D.

OF BALTIMORE, MD.

THIS is the second paper devoted to this subject which I have presented before the American Surgical Association.

I am discussing the value of a course of irradiation with X-rays or radium in cases of clinically malignant tumors which are operable. Further experience since my paper published one year ago and a recent restudy of the entire group of cases of malignant disease subjected to treatment by X-rays or radium convinces me that in every local lesion which presents itself with a clinical picture suggesting the possibility of malignancy and for which in the past and even today surgery has been selected as the treatment of choice, to be followed by irradiation, there should be a consultation between the surgeon and a radiotherapist as to the question of pre-operative irradiation. At the present time this rarely occurs. In the majority of clinics the patient enters the surgical department; the operation is performed, the pathology established, and then post-operative irradiation is considered. This method of treatment has become almost universal after operations for cancer of the breast. In my last paper I called attention to the remarkable results of Mr. Keynes, surgeon to St. Bartholomew's Hospital in London. There has been no publication since his article in the British Surgical Journal in February, 1932. In my previous paper I mentioned my visit to his clinic, and the good impression made upon me by seeing with Mr. Keynes his remarkable results. During the past year, with the rarest exceptions, my cases of cancer of the breast have been subjected to a thorough course of treatment with radium or X-ray before operation. It is impossible as yet to make any statement as to results. I have been unable, in this group, as yet to distinguish any microscopical changes in the tumor tissue and in every instance in which cultures were taken the cancer-cells have grown. This experiment has been carried on with the aid of my colleague, Doctor Burnam, but the experiments are by no means concluded. The character of cancers of the breast coming to my clinic has changed tremendously. In the first place, there is a very large increase in the number of lumps of the breast of very short duration, but which are clinically malignant as based upon slight retraction of the nipple and slight fixation of the skin, and in this group, the glands as a rule are not involved. These patients have at least a 70 per cent. chance of a five-year cure. All I know is that a lethal dose (so-called) of radium given by Doctor Burnam twenty-four to forty-eight hours before the operation produces no change in the cancer-cells when studied micro-

scopically, and these cancer-cells grew when cultivated by Doctor and Mrs. Gey.

I have no evidence that the delay caused by pre-operative irradiation in these very early cases of cancer of the breast is harmful.

This group of malignant tumors of the breast, clinically in the early stages, which have received pre-operative irradiation is very small, and the intervals of time between the irradiation and the operation a matter of a few days. In the discussion, my colleague Doctor Burnam will record the details of his technic and dosage.

In the second group, the cancer of the breast has been more advanced clinically, even up to ulceration of the skin and palpation of the axillary glands. The pre-operative irradiation has been carried on longer, but so far we have been unable to distinguish with the microscope any changes or failure of the cancer-cell to grow. When I say longer, I refer to those cases in which the irradiation was carried for the same period, but the operation was delayed from ten days to two weeks. In my own cases, we have not given post-operative irradiation unless the glands in the axilla were involved. Therefore I will be unable to compare the results of pre- and post-operative irradiation. For some ten years my associate Doctor Kahn and other radiologists throughout the country have given thorough and often repeated post-operative irradiations in cases in which the glands in the axilla have been involved, and I have again and again in recent literature made the statement that I have been unable to find any evidence that post-operative irradiation with X-rays and, in some cases, with radium, has had any effect on the five-year cures. This has been confirmed by the recent work of Williams, of St. Thomas' Hospital, in London.

I take the liberty to state that the operative results of cancer of the breast observed by me are based upon a very large number of operations performed by Halsted himself and by his associates who were taught by Halsted. Mr. Schapiro estimated for Doctor Halsted his first statistics and the figures obtained by him have remained practically unchanged since the first report. They are as follows: Glands not involved, 70 per cent. five-year cures; base glands involved, 25 per cent. cures; mid glands involved, 20 per cent.; apex glands involved, 10 per cent.; supraclavicular glands involved, 4 per cent. These last figures, we now know, are of no particular value, because 4 per cent. of all cancers of the breast, even with the recurrences and skin metastasis to bone, may live in relative comfort for five years. It is in this group that I was unable to determine any improvement in the number of five-year cures after the very best post-operative irradiation. It is essential to know that in every clinic cases of cancer of the breast without glandular involvement or with low glandular involvement, are on the increase. Therefore, even when the surgery is not as efficient as that of Halsted and his specially trained associates, post- or pre-operative irradiation might show apparent improvement which could be explained more readily by the absence of glandular involvement. It will be five years, perhaps, before I will be able to determine the value of pre-operative irradiation in the group with glandular involvement.

PRE-OPERATIVE IRRADIATION IN CANCER

Let me state here that in very few clinics is there any positive record of the exact involvement of glands—base, mid or apex.

I propose, therefore, to continue with pre-operative irradiation in operable cases of cancer of the breast. The number of cases so treated is on the increase.

We have one remarkable observation which I could not record in my first paper, but will be recorded here. This patient had an apparently inoperable cancer of the right breast, due to the tremendous involvement of the breast, although the axillary glands were not palpable. X-ray pictures failed to disclose any metastasis. The patient, although only sixty-five years of age, was feeble and not a good operative risk for a huge dissection of the chest-wall. In this instance irradiation was administered by Dr. Howard A. Kelly and his son. The irradiation was very extensive with the four-gram pack in addition to interstitial irradiation with radon seeds. Nothing else was done for three months. The patient was not at all disturbed by the irradiations. At this time there was such an improvement in the local growth that, after consultation with Doctors Kelly and Burnam, I performed, under avertine anaesthesia, with the electric cautery a complete chest-wall excision of the breast, large area of skin and the lower portion of the pectoral major muscle. No evidence of cancer was found in the periphery of the tissues removed, and, as I could feel no glands in the axilla, no axillary dissection was made, chiefly because the patient was a bad operative risk. This patient had serious post-operative complications—bronchopneumonia, acidosis, mental symptoms suggesting metastasis to the brain, from all of which she made a recovery. Later the granulating wound was grafted. Today, more than one year after operation, there is not a sign of recurrence, and the patient, although still feeble, is well. The microscopical and cultural results were in contrast to these in the previous group. The amount of irradiation given at any one spot was perhaps greater in the first group mentioned. In the first place, the cells failed to grow in tissue culture, although a duplicate piece of that taken for culture showed under the microscope apparently morphologically viable cells. That is, these cells had the same staining characteristics as those in the first group in which they did grow in culture were similar to those and in previous cases in which there had been no irradiation. In this breast which had had this extensive irradiation three months before operation there were found, in many sections, three types of tissue—one, a distinctly new type of connective tissue different from that in the normal breast, in which we could find no remaining parenchyma of the breast and no evidence whatever of cancer-cells, stained or unstained. In a second area we have the same connective tissue with perfectly evident outlines of cancer-cells in which nothing stained but the faint outlines. In a third field were nests of typical cancer-cells which could not be differentiated from those in a cancer of the breast that had not been exposed to irradiation. This is the first time we have been able to prove from the standpoint of cell culture the death of the cancer-cell after irradiation. I am convinced that we have much to learn about pre-operative irradiation in distinctly operable cancer of the breast, and I am

inclined to feel that more time should be devoted to the pre-operative treatment, especially when the glands are palpable and we know that the chances of a five-year cure after surgical treatment alone are only 20 per cent. When the tumor is an early one, small, and the clinical signs of malignancy very recent, and when the glands are not palpable, I think it might be wiser as yet to use the method of irradiation followed by Doctor Burnam.

It should be recorded here that inability to palpate the glands in the axilla does not exclude their involvement, even very extensive involvement.

There is a new group which is constantly increasing and that is the group of clinically benign tumors of the breast which transilluminate dark and should be explored, and the clinically benign tumors of the breast—much smaller than a twenty-five-cent piece, which, even when they do transilluminate light, should also be explored. The indications for exploration lie in the possibility of malignant disease, and to reach a decision from the microscopical study as to what should be done.

In clinics where there is a properly trained pathologist who can recognize cancer and differentiate it from border-line tumors, it seems best to follow this rule with, perhaps, two exceptions: If the frozen section made at the time of the operation shows distinct malignancy, but not a Broder's Group IV, acute carcinoma, and not a distinct pure comedo-duct cancer, the complete operation should follow at once. However, if the sections show a Group IV acute carcinoma or a comedo-duct acute cancer, the tumor should be excised with the cautery, the wound closed and the patient treated as quickly as possible with irradiation.

Two years ago I explored a clinically benign lump of short duration in the upper hemisphere of the left breast. It transilluminated dark and felt like an adenoma. The frozen section showed a Group IV acute carcinoma. The patient was about forty years of age; the glands were not palpable. I immediately performed a very extensive operation with the cautery. The glands showed no evidence of metastasis. In spite of this I gave post-operative irradiation. There was almost immediate skin metastasis, recurrence, and later cancer encuirasse. I feel confident that the patient would have lived in greater comfort if only the tumor had been removed, the wound left open and irradiated. Dr. Max Cutler, who is present during this dictation, asks: "Why leave the wound open?" The probabilities are that it would make no difference in the ultimate result, but such a tumor should be not only cut out with the cautery, but the wound itself cauterized. These wounds left open to heal by granulation give less trouble and heal ultimately just as well as when they are closed and break down secondarily due to either a hematoma or serous exudate from the burnt tissue, or due to the effects of the immediate irradiation. This is a minor point, however, compared with attempting the complete operation after the excision of a small tumor when the frozen section reveals an acute carcinoma of the Group IV type. These patients with recurrence after the complete operation suffer much more and do not get palliative relief equal to those who come under observa-

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tion with the clinical picture of acute carcinoma—operable or inoperable—who receive irradiation but no operation.

Cases similar to this one are on the increase and will continue to increase, because when women delay one month or longer after feeling a lump in the breast, the acute carcinoma rapidly assumes the definite clinical picture of malignancy, then of inoperability and then of cancer en cuirasse. In previous years, every case of cancer en cuirasse was inoperable. Today I frequently see operable cancers en cuirasse. None of them as yet has been cured by the most extensive surgery with post-operative irradiation, nor as yet by pre-operative irradiation. The patients with cancer en cuirasse made most comfortable are those who have received irradiation only—none have been cured.

Now, in regard to the comedo or duct cancer. I saw this first in 1893, forty years ago. Doctor Halsted explored a clinically benign tumor about the size of a five-cent piece; it was not encapsulated; it cupped on section; yet it was not gritty like typical cancer. Its characteristic fresh appearance was: when pressed upon, worm-like, or comedo-like, masses of granular material were expressed. Under the microscope, there were large alveoli containing cells of the Grade I type, some with and some without a central cavity from which necrotic cells have been lost during the hardening and sectioning process. I have been studying this group of duct cancer all these years. This case established the rule. There was nothing in the microscopical section but this typical characteristic histological picture, as typical as colloid cancer. There were no cancer-cells outside these areas; the glands were not involved. The patient lived thirty years and died of other causes. The only cases diagnosed cancer and operated on before 1900 which lived twenty-five or more years were duct cancers of this type which I described as comedo-adenocarcinoma without involvement of the glands. Further evidence of the low grade of malignancy was furnished by a colored woman whose breast was occupied by a fungous tumor, fully the size of a soup plate. A most extensive chest-wall dissection was performed with the removal of the axillary glands. The glands were not involved; the muscle was not infiltrated; every section taken from this huge fungous tumor showed the typical picture of pure comedo, and there was no infiltration of these cells outside the duct. The patient died five years later of cancer of the cervix with no evidence even of local or general recurrence of the breast lesion. There was another more convincing evidence of the benignancy or low grade of malignancy, of the pure type of comedo adenoma or adeno-carcinoma. There is a photograph by Dr. Harvey Cushing, taken in 1898, of a small fungous tumor occupying the scar on the chest-wall after the removal of the breast for some type of breast tumor. Again, the most radical dissection was done; the glands were not involved; the microscopical picture of the fungous tumor was identical with that in the previous case. This patient lived without recurrence ten or fifteen years. Halsted reported these two cancer cases in his paper on adeno-carcinoma. This type of tumor, which is about as uncommon as colloid cancer, may come under observation as a small, clinically benign tumor, or a diffuse involvement of the entire breast not unlike Schim-

melbusch's disease, except that it has always been unilateral. The entire breast may be involved, with the identical histological picture, without involvement of the glands, and the same ultimate cure. One case representing one per cent. of the total number of five-year cases, in which the glands were not involved, died with symptoms of internal metastasis, but clinically a primary abdominal lesion could not be excluded. During this period we have observed about an equal number of scirrhus and medullary carcinomas with microscopical areas of this duct or comedo type. The prognosis in this group is identical with that of medullary or scirrhus carcinoma—70 per cent. of five-year cures when the glands are not involved instead of 95 per cent., and 25, 20, and 10 per cent., according to the extent of glandular involvement.

After this experience, I decided that if I encountered at an exploratory incision a pure duct or comedo adenoma or adeno-carcinoma, I would remove the tumor with the cautery and subject the patient to immediate irradiation, and do nothing more. This happened about six months ago. The tumor was the size of a ten-cent piece in the periphery of the upper hemisphere of the breast. It transilluminated dark like an adenoma. It did not have, however, the distinct encapsulation of an adenoma. Under local anæsthesia I excised the tumor with a good margin of breast tissue. In the gross it was a non-encapsulated area suggestive of malignancy, but it did not feel gritty on cutting like a carcinoma, nor could we express worm-like or comedo masses. The frozen section was diagnosed duct or comedo cancer. The patient was sent at once by automobile to Doctor Kelly's Hospital and given radium treatment over the wound and the axilla. She left for home in her automobile the same day. The wound broke down either from a hæmatoma or irradiation, or both. Remember, the tumor had been excised with the cautery with a good margin of fat and breast tissue. A full course of irradiation was given. The wound now has healed, and there are no palpable glands.

These two cases represent new departures in treatment which I have had under careful consideration for years, especially the duct cancer. I was not prepared, when I explored the acute carcinoma, to restrict the operation to the removal of the tumor only and to depend upon irradiation, not so much for a cure as for prevention of suffering during the short time the patient had to live. We have no evidence that an undoubtful grade IV acute carcinoma of the breast, even without glandular involvement, is ever cured by the most radical surgery, just as we have no evidence that the earliest stage of cancer en cuirasse, operable and without glandular involvement, is ever cured by pre-operative and post-operative irradiation. Nor have we any evidence that a fully developed Paget cancer of the nipple with extensive involvement of the nipple and glands is ever cured by irradiation. When Paget's cancer of the breast is confined to the nipple the prognosis for surgery alone is identical with that for scirrhus cancer of the breast. Perhaps the most difficult problem to solve is when a clinically benign tumor of the breast in a woman at the cancer age is removed and the pathologist examining the frozen section is doubtful as to its malignance. What shall he tell the surgeon to do, or what shall the surgeon decide to do? Formerly, my advice was to give

the patient the benefit of the doubt and do the complete operation for cancer. Today that advice is reversed. It is: Close the wound and, if deep X-ray therapy or a radiotherapeutist with sufficient amount of radium is available give irradiation over the wound and over the axilla. On the theory of probabilities, the chances are that when this section is submitted to a number of pathologists they will either diagnose it benign or doubtful, a few may call it malignant. If the diagnosis of all the pathologists is malignant, finish the course of irradiation and then, if the diagnosis is not acute carcinoma of Grade IV type and not a duct adenoma or adeno-carcinoma, perform the complete operation for cancer. This new point of view about cancer of the breast furnished the best evidence of the new attitude in regard to the treatment of cancer—cancer is no longer a purely surgical disease in which the diagnosis is made clinically and an operation performed. The management of cancer depends upon the coöperative teamwork of an ultra-trained pathologist, radiotherapeutist and a surgeon who still has the training, the conception and the execution of the great pioneers in complete surgery for cancer—Billroth, Kraske, Halsted, Wertheim. When we receive in the laboratory a specimen of a lump removed from the breast, and the section shows undoubted cancer, we advise at once by telegraph a course of irradiation and later the complete operation. It is encouraging to state that this is happening less frequently every month. Most of the tumors of the breast sent to us for diagnosis have been clinically benign, the operator has concluded from the clinical appearance that they are not cancer, and the pathologist has been uncertain. My first experience, beginning more than thirty-five years ago, was the reverse—the tumors of the breast sent to the laboratory for diagnosis were in the gross appearance and microscopically cancer, and we found that in spite of the complete operation with as a rule not more than two weeks delay, the ultimate cures, whether the glands were involved or not, were distinctly less than in the same type of tumor with and without involvement of the glands which were subjected to the immediate complete operation without preliminary excision of the tumor and a delay of two or more weeks.

These remarks in regard to the breast are preliminary. A complete paper will soon follow with greater detail and a little longer interval of time after the treatment of the earlier cases. I have every confidence that this new attitude will not diminish the number of five-year cures, will prevent the unnecessary removal of many breasts, and will add tremendously to the comfort of the individuals suffering with very malignant tumors of the breast. I have given the evidence which has accumulated since I wrote the paper entitled "When Should Irradiation with Radium or X-rays Precede Operation or Be Employed without Operation?" This was written in August of 1932 and published in the *ANNALS OF SURGERY* in November, 1932.

I propose later to give the accumulated evidence which favors irradiation of a cancer of the cervix without preliminary cauterization of the cervix and without hysterectomy after the irradiation. Doctor Burnam, Doctor Cutler and other authorities see no danger in the removal of a small piece with the endotherm loop for biopsy, but they see no advantage in cauterizing the

cervix as is done for erosion preliminary to irradiation for cancer. Doctor Burnam tells me that their final results show that hysterectomy after irradiation yields 15 per cent. fewer cures than irradiation alone, and this is estimated from tumors of the same grade of malignance, clinically and histologically, and Doctor Cutler agrees with this.

Repeated studies by myself of a very large material in the surgical pathological laboratory demonstrate that all types mass of recurrent cancers of the skin and oral cavity, even the smallest basal-cell cancers, should be subjected to irradiation first. All tumors of the soft parts recurring after operation should be irradiated first. All bone tumors in which the X-ray suggests malignancy should be irradiated before biopsy and biopsy should be postponed if there is improvement after irradiation. The evidence favors the conclusion that irradiation has its protective value if given before biopsy.

I am often asked, When shall we perform biopsy? No surgeon should perform biopsy if he expects to subject that case to the advice of a pathologist or radiotherapist upon finding evidence of malignancy or when his pathologist diagnoses malignancy. In terms of golf, none should perform biopsy unless he feels prepared to carry through no matter what is found. If they are not prepared to "carry through" they should call up the selected consultant and ask him about biopsy, because, in some cases, biopsy should be preceded by irradiation. In all cases the method and procedure of biopsy should vary with the localization of the lesion and its extent and duration, its previous treatment. In many instances the lesion is so small that complete excision rather than biopsy should be the method of choice. But even in such cases pre-operative irradiation may add to the probability of a cure with the least mutilation.

In conclusion, we must always bear in mind that pre-operative irradiation may accomplish an immediate and permanent cure even at the risk of a loss of an accurate diagnosis. I have no evidence that properly performed irradiation, when patients are under the supervision of a trained surgeon, pathologist and radiotherapist, ever detracts from the chances of a cure. Pre-operative irradiation also has its diagnostic value, and may elicit important information upon the radiosensitivity and degree of malignancy of the tumor. The greatest danger of pre-operative irradiation is persisting in it too long a time. The fear that pre-operative irradiation interferes with the healing of the wound is exaggerated, and the alleged danger of accelerating the growth of the tumor by irradiation with the doses at present employed is entirely unfounded.

Dr. Max Cutler has been present during the dictation of this paper and agrees with me in this final statement—there have been tremendous changes in the technic of both radium and X-rays with evidence of great improvement in the results, and this is associated with less danger to the blood count. Rarely do we have to perform blood transfusion. In addition, radium sickness has been greatly minimized. Every radiotherapist should familiarize himself with these new improvements.

THE ON-END OR VERTICAL MATTRESS SUTURE

BY JOHN STAIGE DAVIS, M.D.

OF BALTIMORE, MD.

THE suture which I have found most useful in plastic surgery where fine and very accurate approximation is desired in the skin or mucous membrane is what may be called the "on-end or vertical mattress suture." Last year a visitor watching me operate said, "I see you are using the new Sarnoff¹¹ skin stitch! How do you like it?" I did not quite understand what he meant as I was closing the skin with a stitch which I had been using for many years and which I knew others had been using. This remark and the fact that the question is frequently asked as to who was the originator of the on-end or vertical mattress suture and who first described it have induced me to look into the matter. While it seems of little real importance one way or the other who devised the interrupted and the continuous on-end mattress sutures, I feel that to those who contrived these most useful sutures should be given credit for priority especially as the methods are frequently being rediscovered.

My interest in the on-end or vertical mattress suture is solely because I have been using it constantly with the greatest satisfaction since I first saw the interrupted type described in 1909, and the continuous type in 1917. I have searched through the literature on different types of sutures and have not found descriptions of either the interrupted or continuous on-end mattress suture earlier than those to whom credit will be given in this communication.

As one acquires more experience in surgery and becomes more familiar with the literature, one hesitates more and more to claim anything as new. In this connection a quotation from Doctor White's¹⁷ article on "Closing the Skin in Abdominal Incisions" is pertinent. He says in regard to the continuous vertical mattress suture: "We have not seen this suture described or used elsewhere nor has any effort been made to trace the origin, but we are willing to believe that it was in daily use by Hippocrates." This, it seems to me, is exactly the attitude which should be taken when describing any surgical procedure which an author may think is new, because if it is new no harm is done and if it is not, then some embarrassment may be saved, when the original description, which may have been written many years before, is brought forward.

It can easily be seen when reading the original descriptions of the sutures included in this report that the various authors^{4, 8, 12, 13, 19, 20} have devised these sutures without being aware that, in some instances, the same suture had been previously described.

There are two types of on-end or vertical mattress sutures, the *single*, or *interrupted* and the *continuous*, and we will consider them separately.

The Single or Interrupted Type.—As far as I can ascertain, the first to describe and illustrate the single or interrupted on-end mattress suture was Doctor R. M. McMillen,⁹ of Wheeling, W. Va., in 1909. (Fig. 1.) Doctor McMillen has recently sent me copies of letters from Dr. Maurice Richardson of Boston, Dr. John B. Deaver of Philadelphia, Dr. E. C. Dudley of Chicago and Dr. F. W. Huntington of San Francisco, to whom he sent in 1909 a description and drawings of his suture, and all of them speak of it as a suture new to them, in replies written in July, 1909. Coming from prominent surgeons in widely scattered medical centres, it seems reasonable to believe that one of them, at least, might have been familiar with this stitch had it been previously described and used.

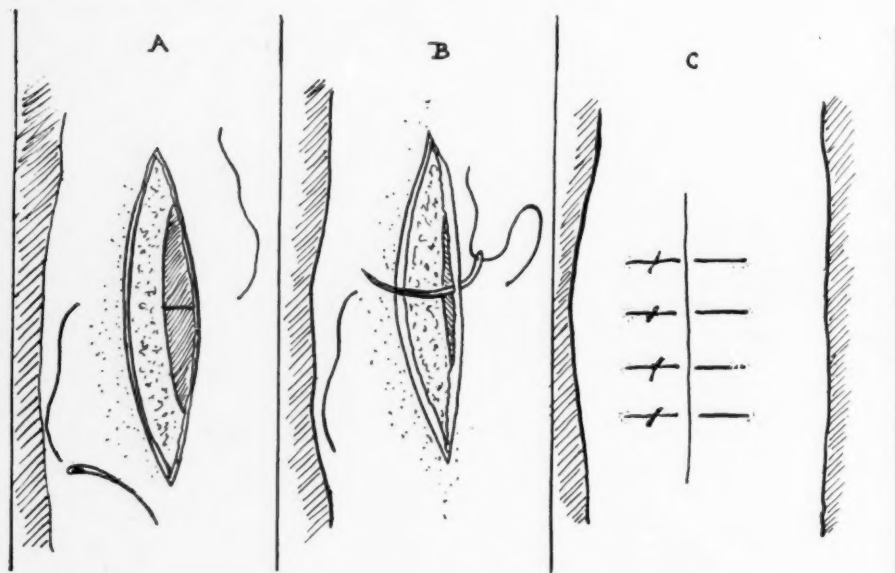


FIG. 1.—The on-end or vertical mattress suture. (Redrawn from McMillen, 1909.) (A) The first or deep part of the stitch is introduced in the same manner as any interrupted suture. (B) The reverse end of the suture is threaded on the needle, or the needle is reversed, and passed through the skin very close to the margin. (C) The sutures are drawn tight enough to bring the deeper portions of the wound together and are tied. The cut surfaces will be in exact apposition and the wound edges slightly everted.

Doctor McMillen's description of the suture is as follows: "First put in the suture the same as the ordinary interrupted suture. Then thread the reverse end of the suture and insert the needle into the skin very close to the edge of the wound, about one-sixteenth of an inch. Pass the needle through the skin only, and on over and catch the skin on the wound side, and come out on the cuticle side about one-sixteenth inch from the edge. (Doctor McMillen has now modified this technic by reversing the needle instead of rethreading the reverse end of the suture.) The suture is then tied by a reef knot drawn with sufficient force to bring the deep structures together. The inner margins of the skin will then be seen to be in exact apposition, and the cut surfaces of the skin will be together when the pressure of the dressing is applied. The knots are at the side of the wound and their removal will not disturb the line of union. The line of union is not constricted by the suture and the blood and nerve supply is not interfered with. This suture reduces the size of the scar to a minimum."

VERTICAL MATTRESS SUTURE

When using the interrupted on-end mattress suture in closing the skin and subcutaneous tissue, I have found it advantageous where there has been loss of tissue to take a few interrupted sutures, either of fine waxed silk or "o" catgut in the subcutaneous tissues to relax the tension, but these subcutaneous sutures are not necessary where there has been no loss of tissue. The knots of these sutures are tied underneath. The skin suture, preferably of horsehair and sometimes of waxed silk, is threaded on two needles, one for the deep portion and the other for the superficial part of the stitch.* With the two needles, it is easier and quicker to pass the deep and superficial portions of the suture in the same direction, than it is to use one needle and

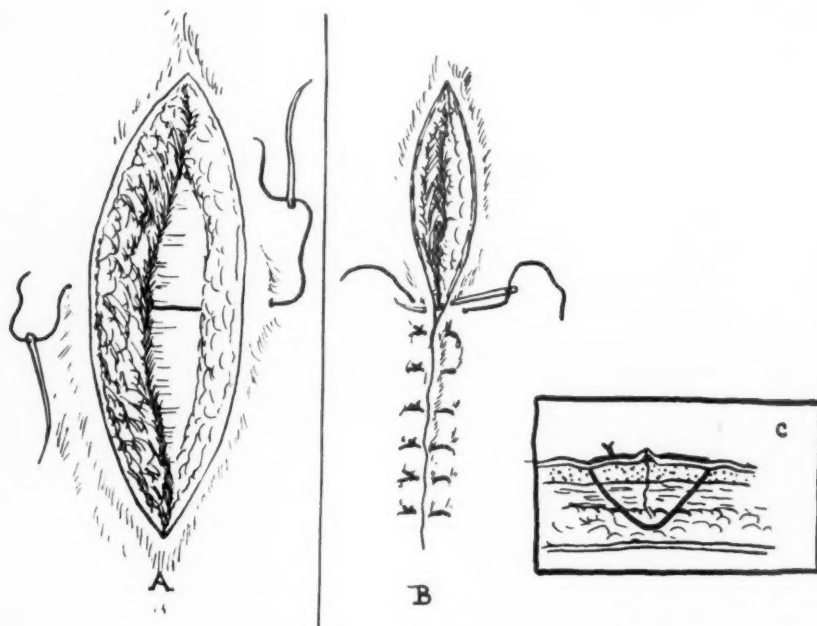


FIG. 2.—The interrupted on-end mattress suture. (Redrawn from Davis and Traut, 1930.) (A) Note the distance between the line of incision and the point of entrance and emergence of the stitch and also its depth. Two half curved Corneal needles are used which slip through the skin easily. The needle for the superficial portion of the stitch is usually somewhat finer so that it will pass through the epithelial margins without tearing. (B) Shows several stitches in place and tied and the needle passing through the epithelial margins, turning them out so that there will be no inverting and no overlapping. (C) Shows a profile view of the interrupted vertical mattress suture. Note the points of entrance and emergence, the depth of the stitch and the turning out of the margins.

reverse it, or rethread it for the superficial portion of the stitch. The first, or deeper part of the stitch, can be made to include as great a depth of the subcutaneous tissue as is desired. (Fig. 2.)

I have found that the finest approximation can be made by picking up

*The needles I have found most satisfactory for skin closure with the on-end mattress suture are the half curved, No. 16 or No. 17, for the deeper portion of the suture as this is a larger needle, and No. 20, which is considerably smaller, for the superficial part of the stitch. Occasionally, I use a small full curved cutting needle for either the deep or superficial portion of the stitch, or have a full curved needle on one end of the suture material and a half curved on the other.

with the second part of the stitch only the most superficial portion of the incised edges rather than by including the fairly deep bite into the corium. It is easier to take a deeper bite but the closure is not so accurate. In dealing with the mucous membrane of the mouth, vagina and bladder, the full thickness of the mucosa should be picked up in the superficial section of the stitch.

Dr. E. Bonnot,³ of St. Louis, in 1915 described the interrupted on-end or vertical mattress sutures as "A New Stay Stitch for Deep Wounds" and speaks of it as "a mattress suture on its side."

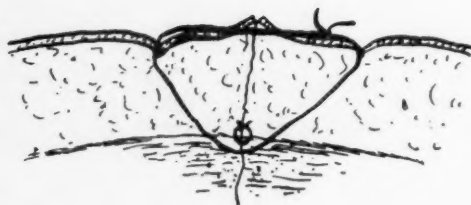
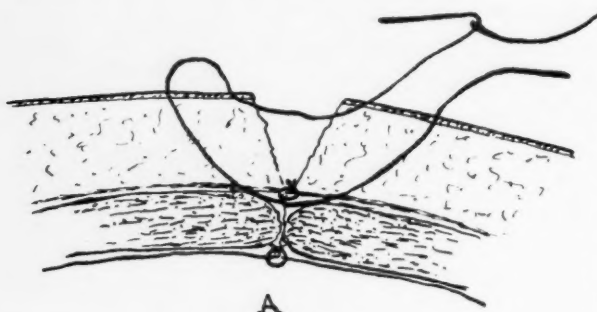


FIG. 3.—A new stay stitch for deep wounds. (Redrawn from Bonnot, 1915.) (A) The needle is inserted about an inch from the edges of the wound through and including the edges of the deep fascia, and out on the other side at the same distance from the wound. (B) The needle is then passed back through the skin one-fourth of an inch from the edges and tied on one side of the wound.

far away from the skin edges and suggests supplementary superficial skin sutures if necessary. (Fig. 3.)

The interrupted on-end mattress suture is sometimes called the Stewart suture after Dr. George David Stewart,¹⁶ of New York. After seeing Doctor Bonnot's article, Doctor Stewart¹⁵ wrote: "Dr. Edmund Bonnot describes and illustrates a stitch which I have been using for many years and which has been adopted by many of my colleagues. By some it is named for me, but it is not mine. I saw it described years ago, but have forgotten the name of the maga-

zine and the author, remembering only that it came from one of the nearer Southern States, perhaps Virginia." Doctor Stewart says further on that he has "always taken pains to disclaim any credit for its invention." It seems likely from what has been said above that it was Doctor McMillen's article to which Doctor Stewart referred.

There is another suture which has also been called the Stewart suture, which was first described as "a combined retention and coaptation suture," in the second edition of the "Manual of Surgery" by Dr. F. T. Stewart,¹⁴ of Philadelphia, in 1911. This suture is certainly an excellent one and is based on the on-end mattress type, but it takes in a much wider and deeper bite of skin and subcutaneous tissue in the second part of the stitch, requires two knots, and does not give as fine a skin closure as the suture devised by Doctor McMillen. (Fig. 4.)

VERTICAL MATTRESS SUTURE

Dr. Vilray Blair,² of St. Louis, has used the interrupted on-end mattress suture for years and illustrated it as a palate flap suture which will not allow

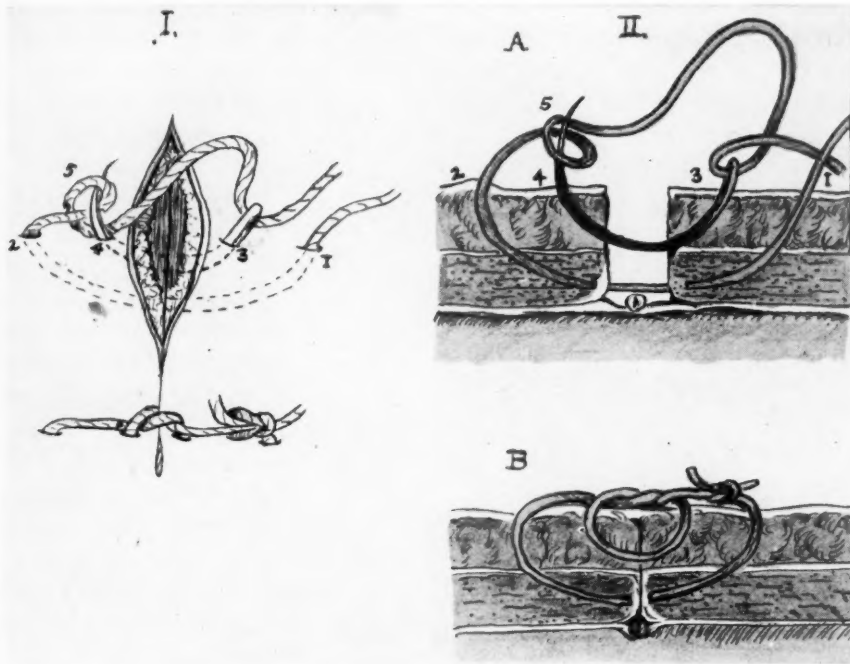


FIG. 4.—The F. T. Stewart suture. (I. Redrawn from the second edition of Stewart's Manual of Surgery, 1911.) (II. Redrawn from the sixth edition, Stewart and Lee, 1931.) The needle is inserted at 1, brought out at 2, reinserted at 3, and emerges at 4, passing through the loop at 5. When drawn tight it holds the wound edges firmly together and prevents inversion of the skin.

cut edges of mucous membrane to overlap, as early as 1912, and also in later publications. (Fig. 5.) All the men who have worked with me for the

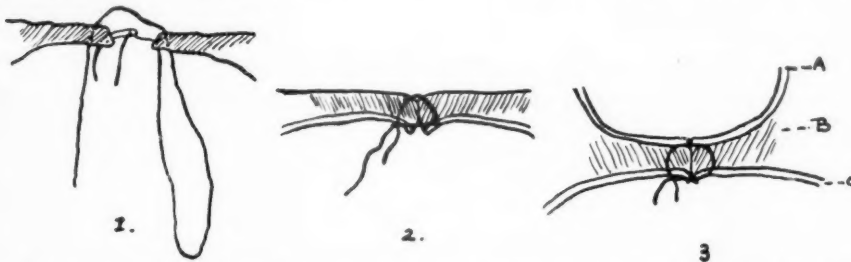


FIG. 5.—Illustrating the on-end or vertical mattress suture used in suturing mucoperiosteal flaps in the repair of a congenital cleft of the palate. (Redrawn from Blair, 1912.) (1) Shows the deep portion of the stitch going through the full thickness of the mucoperiosteal flaps and the superficial portion going through the mucous membrane. (2) Shows the suture drawn snug and the approximation of broad raw surfaces of the flaps and eversion of the mucous membrane. (3) The vertical mattress suture in the soft palate. (A) Mucosa of the nasopharynx. (B) Soft palate tissue. (C) Oral musoca.

last twenty years are also familiar with this stitch, and a number of other authors have described and illustrated it.

The Continuous Type.—In order to show the difference between the con-

tinuous mattress skin suture and the continuous on-end mattress suture, I will illustrate with the following. (Fig. 6.)

Dr. John A. Wyeth,¹⁸ of New York, in his text-book published in 1887, shows a continuous mattress suture for closing the skin and says "the mat-

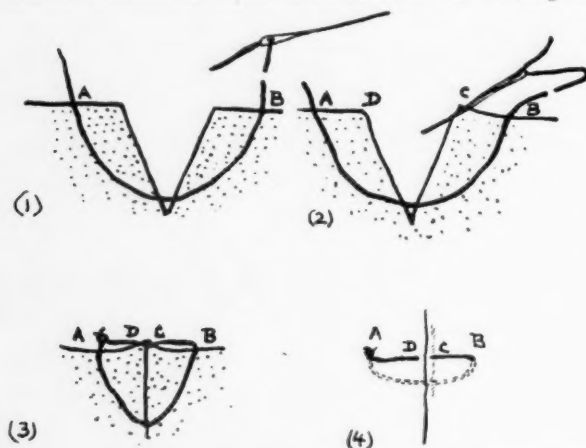


FIG. 6.—A useful skin suture. (Redrawn from Arthur Edmunds, 1918.) (1) The suture is passed from A, across the wound to B, taking up, if required, the whole thickness of the fatty layer. (2) The needle, which should be a fine one, is then inserted through the extreme edge of the wound, C, passing from without inwards and taking up only the very minimum of tissue, then passed through the opposite lip of the wound, D, from the wound to the skin surface. This stitch is identical with the interrupted on-end mattress suture of McMillen.

tress suture shown is practically obsolete and possesses no advantages which do not belong to the interrupted or continuous methods." It may be inferred from this that the use of the continuous mattress suture placed flat was even then not a new one.

In 1912, Dr. Willard Bartlett,¹ of St. Louis, described "a continuous mattress skin suture," which is identical with that described by Wyeth. (Fig. 7.) He summarized its advantages as follows:

"Being a continuous stitch it lends greater speed to an operator than the interrupted stitch. It acts as a good tension stitch with little possibility of cutting through the tissue. It leaves no cross scars. Small longitudinal scars are left, but these are generally not so unsightly. It insures the desired approximation of the epithelial surfaces; prevents the turning-in tendency of the skin and thus guards against infection, through this source, of the deeper structures of the wound."

This suture is much superior to the ordinary continuous skin suture, but differs materially from the continuous on-end mattress type as will be seen. As far as I^{5, 6} can ascertain, the continuous on-end or vertical mattress suture was first described by Dr. C. S. White,¹⁷ of Washington, D. C., in 1917, and he spoke of it as the continuous vertical mattress suture. (Fig. 8.) His description of the stitch was as follows:

"The suture should have a knot or small loop tied in the long end, or fixed by a split knot and begun by taking a deep suture to include the entire thickness of the skin, from one side of the incision to the opposite, about one centimetre from the edge. The needle is then reversed in the holder and the suture passed obliquely toward the other side, or the side on which the suture was started, barely engaging the edges of the wound. The needle is then introduced a trifle lower, on the side on which it originally entered, one centimetre from the edge and the first deep suture is repeated. These deep and superficial sutures are continued until the wound is closed, drawing up the thread gently as each suture is completed." Doctor White used No. 00 or No. 000 chromic catgut.

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I, personally, never use catgut for suturing the skin and feel that in closing wounds, particularly on the face, that a much less conspicuous scar can be obtained by a closure with horsehair, fine waxed silk or some other fine non-absorbable suture material, and that there is considerably less chance of superficial infection.

Dr. J. Sarnoff, of Brooklyn, in 1929 described "A New Hemostatic, Approximation and Tension Suture" as follows:

"In the ordinary continuous stitch one passes the needle through the skin a distance away from the skin edge on one side until it reaches the opposite side of the

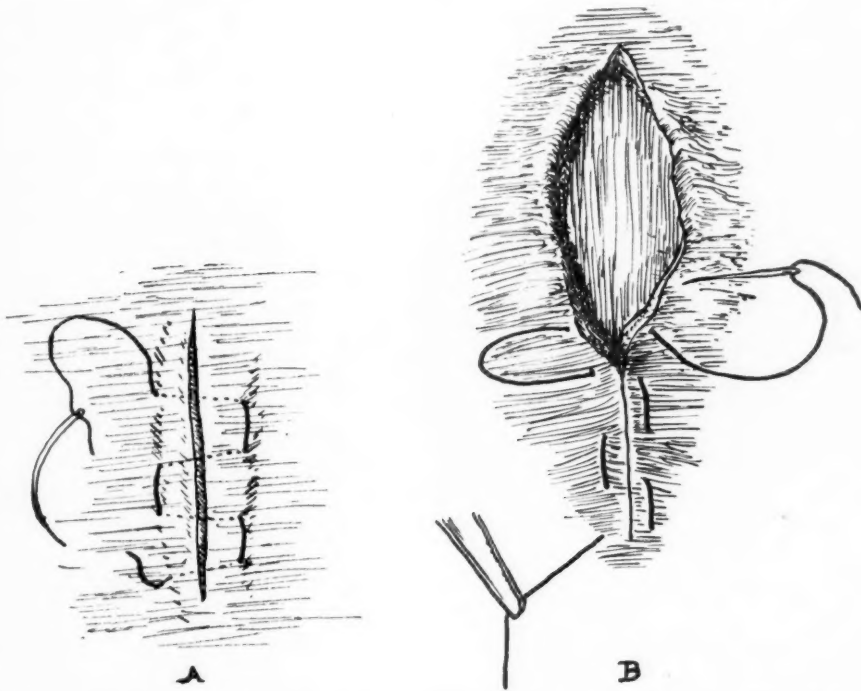


FIG. 7.—Continuous mattress skin suture. (A) (Redrawn from Wyeth, 1887.) (B) (Redrawn from Willard Bartlett, 1912.) The needle is introduced a little to one side at the very end of the wound and passing under the skin is brought out at a point directly opposite. It is then reversed and passed back through both lips, being inserted a little higher along the wound. Sufficient tension is exerted to permit an easy falling together of the wound edges. This procedure is repeated until the wound is closed. It will be noted that the purpose of this suture is to keep the skin edges from turning in and that it is inserted in exactly the reverse way from the continuous mattress intestinal suture of Cushing which is designed to turn in the margins.

incision the same distance away from the skin edge. Then the thread with the needle is carried over the line of incision in an oblique or straight direction to the opposite side and the same process is repeated. In this new suture, instead of carrying the needle over the line of the skin incision to the opposite side as mentioned above, the needle as it reaches the extreme edge of the skin at the line of the incision is first passed through these free edges and is then continued as in the ordinary stitch."

Doctor Sarnoff, in 1931, in a very excellent summary of the advantages of this suture, which is identical with the continuous on-end or vertical mattress suture described by Doctor White says:

JOHN STAIGE DAVIS

"(1) The suture is simple and speedy of execution. It is fool-proof; the edges cannot invert or evert.

"(2) The suture evenly approximates the deep parts of the skin as well as its finest cut edges. It thus provides two wide opposing raw surfaces for healing with a resulting firm subcutaneous as well as cutaneous union of the cut edges. The deep part of the suture takes away any tension on the skin edges and the scar, therefore, does not stretch and widen out, as happens with the average suture.

"(3) The suture prevents puckering between the stitches, which is unavoidable with interrupted sutures and it maintains an even and constant tension on all tissues at the line of suture. One may compare it to a zipper, with its many advantages over buttons.

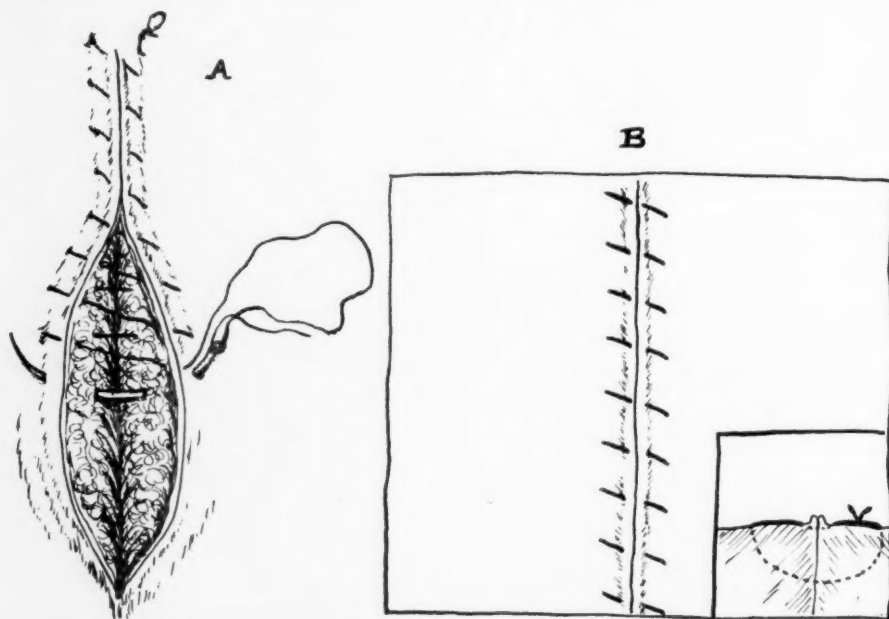


FIG. 8.—(A) The continuous vertical mattress suture. (Redrawn from C. S. White, 1917.) The suture is fixed by any desired method. Starting about one centimetre from the edge a deep suture including the entire thickness of the skin is taken from one side of the incision to the other as in any continuous stitch, emerging the same distance from the wound edge on the opposite side. The needle is reversed in the holder and the suture is passed obliquely toward the other side barely engaging the edges of the wound. The needle is introduced, a trifle lower down and exactly the same process is repeated. The deep and superficial portions of the suture line are continued until the wound is closed, drawing up the thread gently as each section of the suture is completed. (B) A combined superficial and deep continuous suture. (Redrawn from Sarnoff, 1929.) Compare this drawing with A, and it will be found that the sutures are identical and the same description will answer for both.

"(4) The suture effects complete hemostasis at the suture line and obliterates dead space, factors conducive to primary union in its fullest sense in all clean cases.

"(5) The suture is removed with great ease, and the scar left after healing is almost invisible."

The Button-hole Modification of the Continuous On-end Mattress Suture.
—In January, 1918, Dr. Fowler Roberts,¹⁰ of Indianapolis, illustrated a "stitch for the closure of skin wounds," which he described as "a series of on-edge mattress sutures made continuous by looping the suture as in the button-hole stitch instead of tying as in the interrupted on-edge mattress suture." (Fig. 9.) This modification of the continuous type of on-end

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mattress suture is an excellent one and can be used in closing wounds where there is somewhat more tension than in the ordinary incised wound.

Mr. Arthur Edmunds,⁷ of London, in February, 1918, described and illustrated a typical single or interrupted on-end or vertical mattress suture, which is exactly like the suture described by Doctor McMillen⁹ and also a continuous type of on-end mattress suture which is identical with that described by Doctor Roberts. He says of the interrupted type that there are two parts to the stitch, the deep part which obliterates any dead space in the wound, and the superficial part, which holds the extreme edges of the wound and prevents their inversion, actually slightly elevating them, although leaving their epithelial margins in accurate apposition.

Remarks.—When we speak of closure of the skin, we also mean in many instances the closure of the closely associated subcutaneous tissue. Unless



FIG. 9.—(A) Continuous on-edge mattress suture of the buttonhole type. (Redrawn from Fowler Roberts, 1918.) The suture is begun as an ordinary single or interrupted on-end mattress suture, but instead of tying and keeping it the interrupted type, the thread is looped as in the buttonhole stitch and the process is continued until the wound is closed. (B) The button-hole type of continuous on-end mattress suture. (Redrawn from Arthur Edmunds, 1918.) The needle is inserted at A, and is passed as deeply through the fat as may be necessary and emerges at the corresponding point B on the other side of the wound. The needle is then passed through the extreme edge of the wound and tied but not cut. The next stitch is inserted in exactly the same manner, A' to B', leaving the loop of thread, AA', lying close to the skin and parallel to the wound, then through the lips of the wound C' to D', finally passing under the thread AA' and drawing the wound together. This process is continued until the closure is completed. It will be noted that these two sutures are identical although started in the drawings at opposite ends of the incisions.

this closure is very carefully done and the stitches are placed correctly and tied with the exact amount of tension, there may be overlapping or inversion of some portion of the skin edges. This may delay final healing and may also make an uneven scar which, in a conspicuous position such as the face, may subsequently be very annoying. A carefully sutured wound will heal more rapidly and strongly than one in which the approximation has been indifferently done. Asepsis; gentle handling of tissues; complete hæmostasis; elimination of dead spaces and accurate approximation without tissue strangulation are the factors which must be striven for.

In plastic surgery I have found the single interrupted type of the on-end mattress suture to be most satisfactory in closing all skin wounds and especially advantageous in closing irregular wounds; also wounds where there has been destruction or excision of tissue, and where there is more tension on the edges than there would ordinarily be in closing a simple incised wound. The stitches can be removed separately, which is an advantage; the stitch, if properly placed, seldom if ever causes strangulation of tissue. It slightly

everts the cut edges and prevents overlapping or inversion. The closure is strong, as broad raw surfaces the full depth of the suture are brought in close approximation. The scar is much less conspicuous than that following any other type of closure with which I am familiar. I have been able to get good approximation in wounds which could not be satisfactorily closed by any other type of suture. In accident work or where small growths have been excised, and in fact in every closure both in skin and mucous membrane where the edges can be brought together, I usually employ this type of suture. The difficulty, as with any interrupted stitch, is that it takes more time than the continuous type. Of course, reasonable speed in operating or in closing a wound is desirable, but it is far more important to handle tissues with consideration and use meticulous care in getting a good closure than it is to shorten the operating time by a few minutes.

Where there has been loss of tissue and the edges do not fall together as would those of a simple incised wound, in placing the interrupted on-end mattress suture, I frequently alternate silk and horsehair, or supplement a horsehair closure with a few waxed silk sutures.

In closing some wounds, it may be sufficient to take a few rather deeply placed interrupted on-end mattress sutures, at intervals along the length of the incision, to give strength and even approximation and in between these to place very superficial simple interrupted sutures through the skin edges.

One should begin to remove the interrupted on-end mattress sutures as early as twenty-four hours, if the wound is on the face or in some other conspicuous area, and all of them should be out by the third day. The strain on the wound edges is relieved by strips of crepe lisse held in place by collodion, and this type of dressing is continued for about ten days. In less conspicuous portions of the body, the stitches are taken out as they loosen, usually all being removed by the tenth day.

It is seldom that the continuous on-end mattress suture is employed on the face or in other conspicuous positions. This type of suture should be removed anywhere from the seventh to the tenth day depending on conditions.

I use the single or interrupted on-end mattress suture a great deal more frequently than I do the continuous variety as the wounds with which I have to deal in plastic surgery are seldom of the simple incision and closure kind, and the tissues to be sutured are often infiltrated with scar.

I prefer the single or interrupted type as each suture is a separate unit and if any single suture should break or become untied only a small portion of the closure would be affected. Multiple sutures naturally give a stronger, safer closure than a continuous suture which depends on a single thread. When the continuous suture is used, if the tissue should for any reason tear out at any point, or the single thread break, then the result on the entire suture line might be jeopardized. Nevertheless, I have found that in suitable cases the continuous vertical mattress suture is most useful in closing line incisions and it gives in skin and mucous membrane a good strong closure with an inconspicuous scar.

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The continuous type can be used to advantage in closing any line incision in skin or mucous membrane or in fact anywhere, that a continuous suture can be employed and gives a smoother, more even and stronger closure than the ordinary suture. Its application takes very little longer than the ordinary continuous suture, but its advantages, especially in closing incisions in skin and mucous membrane, are obvious.

By the use of the on-end or vertical mattress suture, either interrupted or continuous, dead spaces between the wound edges can be eliminated. In spite of the ease and accuracy with which the skin or mucous membrane can be closed with the on-end mattress suture of either type, there have been, up to the last few years, comparatively few surgeons who have realized the value of this suture.

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THE WATER REQUIREMENTS OF SURGICAL PATIENTS

BY FREDERICK A. COLLIER, M.D., AND WALTER G. MADDOCK, M.D.

OF ANN ARBOR, MICH.

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF MICHIGAN

THE importance of water to the body in conditions of health and disease is generally recognized. We have reported studies¹ on the factors of water loss during the time of operation and in the recovery period. We wish to present here an amplification of those observations on water metabolism to cover longer periods of time. To facilitate an understanding of the terms and methods employed in the investigation, a statement of the general factors of water balance will briefly be given. Due to the nature of many surgical conditions and their treatment, an absolutely accurate study of water exchange cannot be made on surgical patients over long periods of time and some modifications of the standard methods evolved by Newburgh and his associates^{2, 3} were found necessary. However, the observations made are sufficiently accurate to permit valuable deductions.

There are two general sources of water available for the body, the exogenous, comprising the water of the food and the water drunk, and the endogenous, comprising the water of oxidation and the preformed water. Solid food averages 80 per cent. water content. From this source a routine maintenance diet or the usual house diet provides an average of 1,000 cubic centimetres of water a day and the hospital soft diet about 500 cubic centimetres of water a day. This factor obviously plays a small part in the post-operative fluid intake for the first three days; after that time it assumes a more important rôle.

The fluid drunk varies greatly from day to day, depending on the thirst of the individual, normal volumes ranging from 800 cubic centimetres to 2,000 cubic centimetres daily.

The oxidation of the food within the body forms water in proportion to the amount of the material consumed. The oxidation of one gram of protein yields 0.4 gram of water; of fat, 1.07 grams of water; and of carbohydrate, 0.6 gram of water. The determination of this portion of water assumes an accurate knowledge of the amount of protein, fat and carbohydrate being oxidized. This, the metabolic mixture, usually does not correspond to the food intake since the metabolism is seldom exactly the same as the calorific value of the diet, and body tissue may be built up or oxidized to care for the difference. The water of oxidation averages from 200 grams to 400 grams for persons at light activity. The accurate determination of water of oxidation in the sick surgical patient is impossible and is the chief reason for our inability to study water exchange with complete accuracy in this group of patients. This difficulty may arise through changes in the patient's diet, because of the disease and treatment, and sometimes because of changes in the metabolism characteristic of the disease or associated with fever. It has

WATER FOR SURGICAL PATIENTS

been found,² however, that the sum of the weight of the water content of a normal diet and the weight of its water of oxidation is approximately 90 per cent. of the total weight of the diet. This method of calculating the water content of the food and its water of oxidation was used in our study. The error probably never exceeded 200 grams a day.

Preformed water is the body water that is attached to the tissues in the normal manner and is set free when tissue is oxidized. This amount is usually so small as to have no important bearing on the total water balance, but in starvation it may reach the amount of 250 grams a day.

Water is lost normally in the urine, in the fæces, through the skin and lungs, and in abnormal conditions, by vomiting, from intestinal or biliary fistulæ, by diarrhœa, and by wound secretions.

Normal kidneys act so that daily waste products are excreted in a small volume of urine with a high specific gravity or in a larger volume of urine of lower specific gravity, depending on the amount of water available. Waste products excreted by the kidney in solution average about thirty-five grams daily.⁴ There must be at least 600 cubic centimetres of urine excreted daily to carry away these solids in solution. Normal urine volumes are generally well over 95 per cent. water.

The water lost in fæces of normal man is usually not more than 200 cubic centimetres, varying ordinarily from 60 to 150 cubic centimetres daily. This loss is normally, therefore, trivial compared to the total output. In surgical patients, however, loss from the gastro-intestinal tract by vomiting, from intestinal or biliary fistulæ, or by diarrhœa may reach large amounts that will in a short time lead to dehydration.

There is a continuous insensible loss of water from the lungs and skin that is always a large amount and may be the greatest part of outgoing water even under normal conditions. This loss is largely concerned with the regulation of body temperature and over a considerable range of body activity short of physical labor this evaporation of water accounts for about 24 per cent. of the heat lost. Newburgh and his associates⁵ have shown that this water vapor varies from 85 per cent. to 100 per cent. of the total insensible loss of weight, shifting with the composition of the metabolic mixture oxidized. The other component of the insensible loss is the difference between the weight of outgoing carbon dioxide and the incoming oxygen. Studies⁵ of this insensible loss at normal activity show the daily quantity to average from 1,000 cubic centimetres to 1,550 cubic centimetres. We considered, then, in our calculation the total insensible loss of weight as entirely water with the introduction of a slight but practically negligible error.

The procedure carried out in each case studied is shown in Table I. The patients were under constant day and night supervision by one of us to insure accuracy. In short, the method was designed and carried out to determine as accurately as possible under the circumstances the amounts and sources of fluids of intake and output.

In Table II are shown the components of water exchange on a simple surgical case. The patient was a girl of twelve on whom a short operation for the closure of a parotid

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TABLE I
Outline of Procedure

WEIGHT IN GRAMS OF:-	NAME-----	DATE-----
1. Patient.* Time-----	Weight of patient + Bradford frame + coverings + dressings ----- Weight of -----	-----
2. Food. Tray + dishes + food Tray + dishes	Breakfast ----- Dinner ----- Supper ----- ----- + ----- + -----	-----
3. Water drunk.	Gallon thermos jug with drinking tube through notched cork ----- Filled H ₂ O ----- Remaining H ₂ O -----	-----
4. Urine	5. Stool	6. Vomitus
7. Special in.	8. Special out.	
Covered pail + 24 hour specimen	-----	-----
Covered pail	-----	-----
Sp. gr.	-----	-----
9. Blood loss in O.R. (4)	10. Surgical specimen.	11. Total intake.
12. Sensible total output.	13. Insensible loss. Weight patient start----- + total intake ----- minus ----- Weight patient end ----- + sensible total ----- output -----	14. Total output. -----

fistula was performed under nitrous oxide and oxygen anaesthesia. It will be observed that on the two days prior to operation the water of intake, from the food eaten and water drunk, was approximately 3,000 grams. The insensible loss for this period was close to 900 grams a day. This left about 2,000 grams of water for kidney function; consequently the urine is about that amount with a low specific gravity. Therefore, on these days she is in water balance as shown by a comparison of the total intake and

TABLE II

Date	1932	Dec.14	Dec.15	Dec. 16	Dec.17	Dec.18
Weight in grams of:-				Opera- tion		
Patient	30413	30520	30267	29825	30339	
Food	1122	1182	215	1081		
Water drunk	2124	1785	708	1926		
Urine	2245	1982	222	1670		
Sp.gr.	1.011	1.006	1.030	1.006		
Stool	0	185	0	0		
Vomitus	0	0	269	0		
Blood			15			
Insen.loss	894	1053	859	823		
Max.temp.°F.	98.6	99.2	98.6	99.0		
Total intake	3246	2967	923	3007		
Total output	3139	3220	1365	2493		

A girl, aged twelve. Operation, closure of parotid fistula under nitrous oxide and oxygen anaesthesia.

output and confirmed by the constant body weight. On the third day she was operated upon and in spite of the total intake being lowered to about 1,000 grams, the insensible loss was unchanged. The water lost by vomiting and the lessened intake is all reflected in the small amount of urine of a maximal specific gravity. This volume of urine is too low to excrete urinary solids for that day. The following day the intake was back to the pre-operative level and the urine volume was increased with a consequent reduction

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of its specific gravity. The weight loss noted on the day following operation represents water abstracted from the body's interstitial water. On the following day (December 17) the process is reversed and the patient gaining weight. We wish to emphasize especially that the insensible loss remains constant while the lowered intake is reflected in the urinary water.

In Table III are shown the observations on another simple surgical case. A healthy woman of forty-one years was operated upon for an inguinal hernia under nitrous oxide and oxygen anaesthesia. On the day prior to operation the total intake of available water was low while the output was nearly 1,000 grams more than the intake. Such differences are frequently found on any one day in normal people. On the day of operation there was a slight increase in the insensible loss and a marked diminution in the amount of urine with a consequent rise of its specific gravity. The intake on this day was too small but no water was given except orally since she was expected to take adequate amounts soon. On the following day a larger intake resulted in a rise of urine volume to a satisfactory level. One again notes the constancy of the insensible loss with the reflection of the diminished intake in the lessened amount of urine.

TABLE III

Date. 1933	Jan.11	Jan.12	Jan.13	Jan.14
Weight in grams of:-		Opera- tion		
Patient	67990	67170	66615	66388
Food	1541	0	486	
Water drunk	842	1561	1949	
Urine	2127	693	1647	
Sp.gr.	1.012	1.026	1.007	
Stool	0	0	0	
Vomit	0	213	0	
Blood	0	22	0	
Insens.loss	1076	1188	1015	
High temp. °F.	99.0	99.6	99.2	
Total intake	2383	1561	2435	
Total output	3203	2116	2662	

Table IV gives the results of the observations on a boy, eleven years old, weighing 28.8 kilograms

A woman, aged forty-one years. Repair of a right inguinal hernia under nitrous oxide and oxygen anaesthesia.

(sixty-three pounds) who gave a history of an attack of acute appendicitis three days prior to the time of entrance to the hospital. He had been purged before coming to the hospital. On entrance he presented a typical clinical picture of peritonitis complicating acute appendicitis. It was decided to treat him conservatively (Ochsner method) and in the following twelve days he was restored to normal without operation. During the first nine days nothing was given by mouth, the entire fluid intake being maintained intravenously. Each day he received 1,000 cubic centimetres of normal saline, the remainder of the fluids as 5 per cent. glucose solution. The water losses were largely urine and insensible loss with a small amount of vomitus. The insensible loss was remarkably constant at a figure just short of a litre a day during the febrile period. This loss was high for a person of his size and undoubtedly due to the increased heat production of fever. That the intake was adequate is shown by the urinary output which averaged more than two litres a day with a low specific gravity. During the entire period of study there was a daily loss of weight of about 250 grams, which can be accounted for by oxidation of tissue above the calorific intake. A comparison of the intake and output day by day shows a satisfactory water balance for the entire period. It is of some interest to note that there was no movement of the bowels until the tenth day, when water was given by mouth.*

* We believe that the use of enemas in this group of patients is unwise and this and other similar observations show that no harm comes from failure of the bowels to move while under this treatment. When food or drink is eventually taken into the gastro-intestinal tract, the bowels move again.

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In Table V are shown the observations on a young man of seventeen years with an acute exacerbation of an extensive chronic osteomyelitis of the right tibia complicated

TABLE IV

Date	1933	Feb.20	Feb.21	Feb.22	Feb.23	Feb.24	Feb.25	Feb.26	Feb.27	Feb.28	Mar.1	Mar.2
Weight in grams of:-												
Patient		28815	28305	28091	28480	27925	27621	27642	27586	27052	26751	26437
Food		0	0	0	0	0	0	0	0	0	0	0
Water drunk		0	0	0	0	0	0	0	0	0	624	
Intravenous		3270	3755	3221	3125	3710	2635	3372	3178	3250	2310	
Urine		2622	2809	1857	2605	2985	2694	2187	2797	2777	2456	
Sp.gr.		1.005	1.004	1.005	1.007	1.009	1.008	1.008	1.004	1.002	1.009	
Stool		0	0	0	0	0	0	0	0	0	80	
Vomitus		179	191	22	94	66	62	52	0	0	0	
Insens. loss		1088	969	953	981	963	858	1189	915	774	742	
Max. temp. °F.		100.6	100.0	102.0	102.0	101.8	100.6	99.0	99.2	99.4	98.8	
Total intake		3370	3755	3221	3125	3710	2635	3372	3178	3250	2934	
Total output		3880	3969	2821	3680	4014	3614	3428	3712	3551	3248	

Boy, aged eleven. Acute appendicitis, duration three days with general peritonitis. Treated conservatively (Ochsner) without operation.

by a purulent arthritis of the knee-joint. Positive blood cultures of *Staphylococcus aureus* were obtained on two occasions prior to the disarticulation of the knee, done on March 8.

The intake was by mouth in the form of food and drink except the day before, the day of, and the day after operation, when it was given intravenously as blood and 5 per cent. glucose solution. The output was through the insensible loss and urine except for a small amount of vomitus on one occasion. The insensible loss was high, reaching 2,500 grams on the day of the operation. We have shown in a previous report¹ some of the factors that increase this form of water loss during the operation. For the fébrile stage of his disease, the heat production was high and consequently the loss of heat by evaporation must be high with a marked increase in the water lost through this channel. With an improvement in his condition and with a diminution of the fever this loss slowly fell. It is wise to think of the insensible loss in a septic patient as amounting to about two litres a day. The urinary output was usually kept well over two litres a day with a low specific gravity.

In Table VI are presented the observations on a man of thirty years with a

TABLE V

Date	1933	Mar.7	Mar.9	Mar.9	Mar.10	Mar.11	Mar.12	Mar.13	Mar.14	Mar.15	Mar.16	Mar.17	Mar.18	Mar.19	Mar.20
Weight in grams of:-			Operation												
Patient	51378	52164	46818	45788	44151	43252	42816	42531	41988	41879	41098	40646	40579	40438	
Food	132	0	310	540	833	983	1425	1094	1255	1242	1250	1692	1472		
Water drunk	1382	43	1045	3651	2812	2113	2810	2401	3310	2217	2216	2414	1176		
Intravenous Transfusion	4691	6757	5706	0	0	0	0	0	0	0	0	0	0	0	
Urine	2767	4218	6048	4031	2225	1437	2637	2264	2102	2556	2205	2916	1416		
Sp.gr.	1.008	1.011	1.006	1.004	1.007	1.013	1.008	1.009	1.006	1.008	1.010	1.007	1.012		
Stool	0	0	0	87	544	333	240	224	103	206	239	80	132		
Vomitus	64	0	0	0	0	0	0	0	0	0	0	0	0	0	
Blood Specimen	527	5059													
Insens. loss	1598	2457	2043	1710	1775	1772	1644	1540	1469	1488	1464	1277	1540		
Max. temp. °F.	103.8	103.0	103.8	101.6	101.2	100.2	100.0	100.6	99.8	99.6	99.0	99.4	99.6		
Total intake	6215	7315	7061	4191	3645	3096	4236	3485	4555	3459	2468	4106	2648		
Total output	5429	12661	8091	5828	4544	3542	4521	4028	4674	4250	2908	4173	2889		

Male, aged seventeen. Acute exacerbation of chronic osteomyelitis of tibia with purulent arthritis of knee. Operation, disarticulation at knee under nitrous oxide and oxygen anesthesia.

pulmonary abscess. Six days before our studies began he had had ribs resected and the pleura packed preparatory to drainage of the lung abscess which was done on March 4. He was septic and ran a fever of about 100° F. Intake was entirely by mouth. The outstanding interest in this case is the daily insensible loss that averages above two litres, the maximum reaching 2,729 grams during the acute stage of the disease. In spite of this high insensible loss, the urine was maintained at a volume of

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over 2,000 grams a day. On the day of operation it will be noticed that 165 grams of serum were aspirated from the wound. The loss of fluid from the wounds was trivial in the other cases studied but it is clear that many surgical patients with burns, large wounds or draining abscesses might lose amounts of fluid from this channel that over the course of time would be important and in such cases allowance for this loss must be made.

TABLE VI

Date 1923	Feb.23	Feb.24	Feb.25	Feb.26	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10	Mar.11
Weight in gms. of										Oper- ation							
Patient	60603	60018	59634	59464	58705	58213	57944	58060	57651	57142	56849	57536	57003	56503	56261	56440	56171
Food	1480	1587	1728	1562	1662	1518	1102	1727	1802	597	1676	1518	1659	1691	1636	1697	
Water drunk	2792	3459	3584	3675	2327	3970	3921	3931	2753	3220	2549	2944	2295	2572	2808	2515	
Urine	1700	2934	3164	3071	1960	3581	3639	3930	3269	1590	1958	2779	2271	2435	2231	2437	
Sp.gr.	1.014	1.011	1.011	1.012	1.018	1.009	1.012	1.009	1.012	1.013	1.015	1.011	1.013	1.011	1.017	1.011	
Stool	204	125	0	206	209	226	0	213	185	0	0	105	211	0	0	0	
Drng. wound										165							
Blood										103							
Sputum	124	90	55	47	60	43	57	30	37	13	24	25	32	18	21	22	
Insens. loss	2729	2231	2263	2172	2152	1997	2121	1914	1573	2339	1956	1726	1940	1942	2112	1676	
Max. temp. °F.	101.4	100.0	100.4	99.8	100.0	99.6	99.2	99.6	99.6	100.0	99.6	99.0	98.8	99.6	99.8	99.6	
Total intake	5572	4996	5312	4937	3989	5468	6032	5658	4555	2917	4225	4262	3954	4653	4444	4212	
Total output	5857	5380	5482	5596	4381	5857	5887	6087	5064	4210	3928	4595	4454	4295	4265	4481	

Male, aged thirty years. Pulmonary abscess. Preliminary rib resection performed on February 17, six days before this study was started. Pulmonary abscess drained on March 4.

Table VII gives the observations on a man, fifty-one years old, with exophthalmic goitre of moderate severity. His basal metabolic rate was a +27 per cent. the day before operation. A subtotal thyroidectomy was done on February 16. Water was taken in by food and drink during the entire time of observation excepting food on the day of operation and the day following. A subpectoral infusion was given on the

TABLE VII

Date 1923	Feb.14	Feb.15	Feb.16	Feb.17	Feb.18	Feb.19	Feb.20	Feb.21	Feb.22
Weight in grams of:-			Oper- ation						
Patient	53543	54194	54662	55473	54188	53263	53965	53999	53893
Food	1711	1767	0	0	1545	1459	1492	1868	
Water drunk	2942	3009	611	2829	3451	3062	2595	2576	
Hypodermoclysis			3065						
Urine	1885	2313	735	2649	3896	2064	2101	2768	
Sp.gr.	1.013	1.013	1.021	1.007	1.007	1.011	1.011	1.010	
Stool	281	40	0	0	183	196	124	107	
Vomit	0	0	85	0	84	0	0	0	
Blood			100						
Specimen			61						
Insens. loss	1827	1954	1886	1464	1758	1559	1628	1675	
Max. temp. °F.	98.6	98.8	99.8	101.2	100.8	99.6	99.0	99.0	
Total intake	4654	4776	2676	2829	4996	4521	4087	4444	
Total output	4003	4307	2867	4113	5921	3819	4053	4550	

Male, aged fifty-one, with exophthalmic goitre. Basal metabolic rates +50 per cent., +27 per cent. Subtotal thyroidectomy under nitrous oxide and oxygen anaesthesia on February 16.

day of operation. Water left the body mainly by the insensible loss and the urine. The urinary output was adequate to keep the specific gravity low except on the day of operation when it fell in amount with a consequent rise in its specific gravity. The insensible loss averaged about 1,800 grams a day which is of some interest if we compare this patient with that of Table III. In both instances a short operation with about the same amount of trauma was carried out. Yet we find the insensible loss has increased 80 per cent. in the instance of the patient with hyperthyroidism. Due to increased heat production from the increased metabolism and the fever, greater quantities of water were used in the dissipation of heat by evaporation. The day following operation there was a definite diminution in the insensible loss of water associated with an increase in body temperature. This observation differs from the

behavior of the insensible loss in patients with fever due to infection. A complete discussion of this point involves the consideration of heat-regulating factors not pertinent to the subject of this paper and will be presented in another publication⁶ on water exchange of patients with hyperthyroidism. The outstanding fact remains that the daily insensible loss of water of a patient with hyperthyroidism is high.

Comment.—We have enumerated the fractions of water intake and output in health and presented observations on these facts in six surgical patients with varying kinds of lesions. We have tried to emphasize the importance of taking each of these water factors into account. Water leaves the body through the insensible loss from the skin and lungs, from the gastro-intestinal tract by vomiting, by diarrhoea and through fistulae and as urine. It must be emphasized that the body will use its water to remove heat by evaporation from the skin in its attempt to maintain the body at a constant normal temperature at the expense of water going to the kidneys. In other words, the water of the insensible loss has preferential rights over the water of urine. Fluids lost from the gastrointestinal tract are absolute losses serving no physiological function. Therefore, with known positive losses, of at least two litres a day from the skin and lungs, a possible amount from the gastro-intestinal tract, one can compute the water needs for the next day by adding to these the estimated amount of urine required. This factor of two litres a day allowed for insensible loss is adequate for most cases and more than enough for the usual surgical case. We have shown¹ that the surgeon has some control over this loss. Patients placed in the old-fashioned ether bed lose about 300 cubic centimetres more from the skin and lungs during the recovery period from operation than do patients given lighter bed clothing. It is far easier to save water when possible than to lose it and replace it. We cannot see any more excuse for putting a patient after operation in a sweat bed than we can for the use of the old-time purge. Both procedures deprive the patient of water needlessly.

The kidney functions with the water available after other physiological processes have been provided for. In estimating the amount of urine desired, it is necessary to know the function of the kidney. If fluid is restricted, the urine arrives at a point where the greatest possible concentration of solids is carried. The normal individual excretes thirty-five to forty grams of solids per day and fifteen grams of water are required⁴ to carry each gram of solids with the normal kidney working at maximum concentration. If the patient cannot get this amount of water, retention of waste products occurs. About 600 cubic centimetres of urine are then the minimal amount for the normal individual. In patients with kidney disease the kidneys cannot concentrate in a normal manner^{4, 7, 8, 9} and as high as forty grams of water may be necessary to carry away each gram of solids, in which instance about 1,600 cubic centimetres of urine would be necessary to prevent retention of solids. We feel that in every instance where the function of the kidneys is under question, a concentration test^{8, 9} should be done. Often, however, this cannot be carried out because of the acute nature of the disease or because of the undesirability of restricting fluids. Important information concerning the

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kidneys can, however, be obtained by observing the specific gravity of the urine obtained from a patient who is dehydrated from disease or poor treatment. If the urine has a specific gravity of 1.030^{8, 9} the kidneys have a normal power of concentration. The first urine specimen after operation is also usually concentrated and here likewise the specific gravity will often give this same information. If the concentrating power of the kidney is normal or known, one can be certain of an adequate supply of available water if the specific gravity of the urine is definitely below the maximal concentrating power. We consider an adequate water intake to carry on the normal physiological activities of the body, one that provides for two litres of insensible loss, covers losses from the gastro-intestinal tract and furnishes at least 1,500 cubic centimetres of urine with a specific gravity of not more than 1.015.

In the condition of dehydration it must be remembered that when the body loses some of its own water it has also been deprived of some of its important minerals. Gamble and his associates¹⁰ have emphasized the apparently important physiological requirement of the interstitial body fluid for a nearly stationary concentration of its substances. Water lost from the skin and lungs is accompanied by negligible amounts of inorganic salts compared to the amounts in interstitial body fluid. Therefore, this water loss would result in a concentration of inorganic salts in the interstitial fluid unless the excess is excreted through the kidney or water is added to the body. If intravenous methods are necessary, an isotonic glucose solution, 5 per cent., will supply the water, the glucose being rapidly oxidized. As is well known, fluids lost from the gastro-intestinal tract contain body fluid materials, chiefly sodium and chloride ion. Water alone will not restore body fluid volumes under this circumstance. The lost minerals must be replaced at the same time. Accordingly, for intravenous administration, physiological sodium chloride solution should then be given.

A word of caution may be given in regard to the intravenous use of highly concentrated solutions of glucose in dehydrated patients, since they abstract water from the body rather than restore it.

We do not infer that the usual surgical patient does not get enough fluids. Clinical experience has shown that patients usually do well with fluid intakes given on clinical indications alone. We do not believe that harm is done by the administration of larger amounts of fluid than are necessary to maintain water balance, but if excesses are given, it adds to the discomfort of the patient, and interferes with rest. The therapeutic use of water above the physiological requirements may have value but a discussion of this point is not in the province of this paper. By our analysis of the amounts of fluid lost from various sources, we offer a chance to compute and administer fluid in amounts approximating rather accurately the patient's physiological needs.

SUMMARY.—(1) A study was made of six surgical patients over periods of several days to determine their increments of water exchange.

(2) A comparison of fluid ingested as such with the urine output does not give a true picture of water exchange.

(3) The insensible loss of the sick surgical patient varied in general from 1,800 cubic centimetres to 2,750 cubic centimetres with a rough average of two litres per day. This fluid has preferential right over water excreted through the kidney.

(4) The water requirements of the surgical patient can be determined by adding this constant factor of two litres to losses from the gastro-intestinal tract and then to an amount of fluid corresponding to the amount or urine considered necessary.

(5) If the concentrating power of the kidneys is known, the body will have an adequate supply of water if the specific gravity of the urine is definitely below the maximal concentration.

(6) It is considered that an adequate water intake is one that provides for a two-litre insensible loss, covers fluid losses from the gastro-intestinal tract, and furnishes 1,500 cubic centimetres of urine of a specific gravity of not more than 1.015.

(7) Water needs of the body can be calculated with an adequate degree of accuracy obviating the dangers of too small an intake and the discomforts of one too large.

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